DRSAR/SA/R-18*

AN ANALYST/USER MANUAL FOR THE DIRECT FIRE COMPUTER PROGRAM

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)* The JMEM/SS Model for the Direct Fire Computer Program was developed to evaluate direct fire projectile warhead kill mechanisms against typical battlefield tactical elements such as armored vehicles. Kinetic energy and shaped charge rounds characterize the projectile warheads most frequently employed by the Simulation Model.

The program utilizes a Monte Carlo sampling technique to determine round aimpoints, round impact points, target kills, and time-to-kill values. After completion of all Monte Carlo trials, successive Pk and Ph trial results are

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accumulated and reduced to mean values for program output which includes mean target Pk data, mean time Pk data, mean target Ph data, mean time Ph data, and the average number of rounds fired per kill.

This report contains:

1. A description of the mathematical model used in the simulation program.
2. A conceptual flowchart of the simulation program.
3. A discussion of the FORTRAN statements that constitute the Simulation Model.
4. Instructions for input data preparation.
5. A sample problem.
6. A source listing of the program.

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SECTION I

INTRODUCTION

SCOPE

The JMEM/SS Model for the Direct Fire Computer Program was developed in 1973 by the Material Systems Analysis Division, Rock Island Arsenal, Ill., in conjunction with a JMEM Methodology and Evaluation Working Group. Its purpose is to evaluate direct fired projectile warhead kill mechanisms against typical battlefield tactical elements. The projectile warheads most frequently used in the simulation model are characterized by kinetic energy and shaped charge rounds.

Program output includes mean target Pk data, mean time Pk data, mean target Ph data, mean time Ph data, and the average number of rounds fired per case.

These results are accrued from 9,604 Monte Carlo trials which yield target Pk and time Pk results for four selected target kill criteria such as mobility kills, firepower kills, mobility/firepower kills, and catastrophic kills. Personnel casualties for an APC (Armored Personnel Carrier) type target can also be evaluated. The computational sequence for a Monte Carlo trial is shown in Figure 1-1.

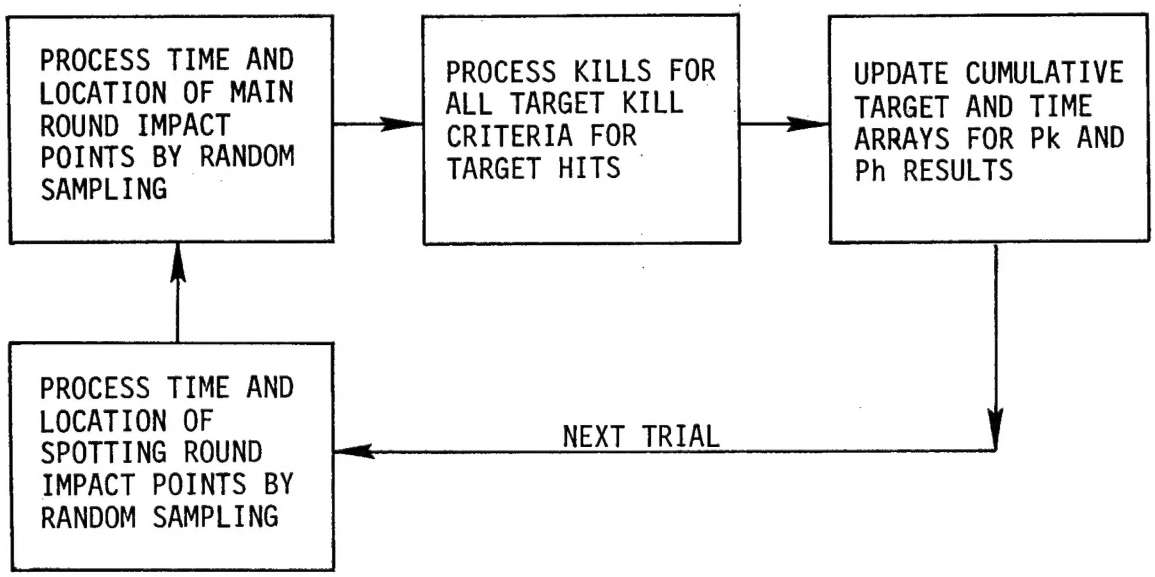

Figure 1-1. Basic Trial Methodology

The four target kill criteria are associated with each point target for a given input data set. The target area is described by grid cells on a target-enveloping rectangle with dimensions determined by the

extremities of the target form as shown in Figure 1-2. Input target Pk coordinates are converted into the identifying kill (IK) array subscripts which correspond with the subscripts of the target-enveloping grid area arrays (AX and AY). The input provides a Pk map which correlates the target vehicle grid cells with associated vulnerability data. Thus, only those grid cells which have correlating vulnerability data identify the target form.

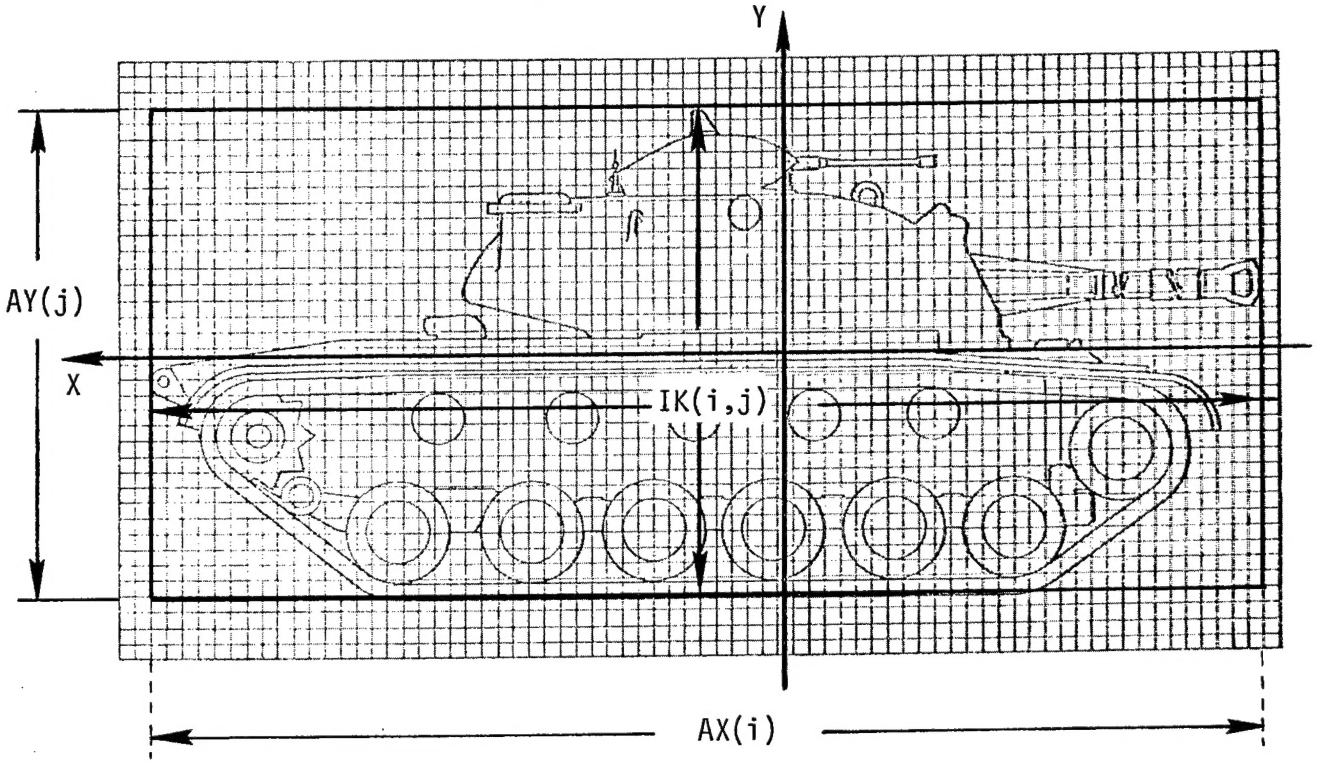

Figure 1-2. Target Description

The Monte Carlo sampling technique establishes locations for round aimpoints and impact points for both main rounds and, if applicable, spotting rifle rounds (used as a delivery assist device). If the target is hit by a main round, tests are performed to ascertain the level of damage inflicted. Monte Carlo sampling is also used to determine firing time factors contributing to the evaluation of time-to-kill.

The successive Pk and Ph trial results are accumulated and reduced to mean values for program output after completion of all the Monte Carlo trials.

COMPUTER REQUIREMENTS

The program accepts card input data, contains about 400 source statements, and requires approximately 200,000 bytes of core. An average target/weapon simulation consumes about 6 minutes of IBM 360 running time. JMEM groups constitute the major users of this program in the field.

Preparation of complete vulnerability data for a target may prove to be a laborious task since the data is not of a general nature but describes only a specific attack elevation and azimuth angle for a specific kill criterion and weapon. Users can obtain the required vulnerability data from BRL, Aberdeen Proving Grounds, Md.

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SECTION II

MATHEMATICAL MODEL

DELIVERY ERROR MODEL

A Monte Carlo sampling technique is used to estimate the projectile aim and impact point locations. It is assumed that the true aimpoint of the projectile is normally distributed about the intended aimpoint, and the projectile impact point is normally distributed about the true aimpoint.

Main Round

The aimpoint (center of impact or CI) of the first main round for each trial is distributed probabilistically about the target. The aimpoint of succeeding rounds fired within a sample either remains the same or is modified by a sensed miss. Thus, during the course of the trials, the group of impact points will tend to be distributed about the target according to a probability distribution which is dependent on the aiming accuracy. The aimpoint of the first main round is determined by supplying a random normal deviate representing the system delivery error contribution to the aimpoint probability distribution in accordance with the following equations. This is illustrated in Figure 2-1.

$$XC1 = (R1)(\sigma_{XB}) + XC + XB \tag{2-1}$$

$$YC1 = (R2)(\sigma_{YB}) + YC + YB \tag{2-2}$$

where

XC1 = horizontal center of impact for main rounds (inches)

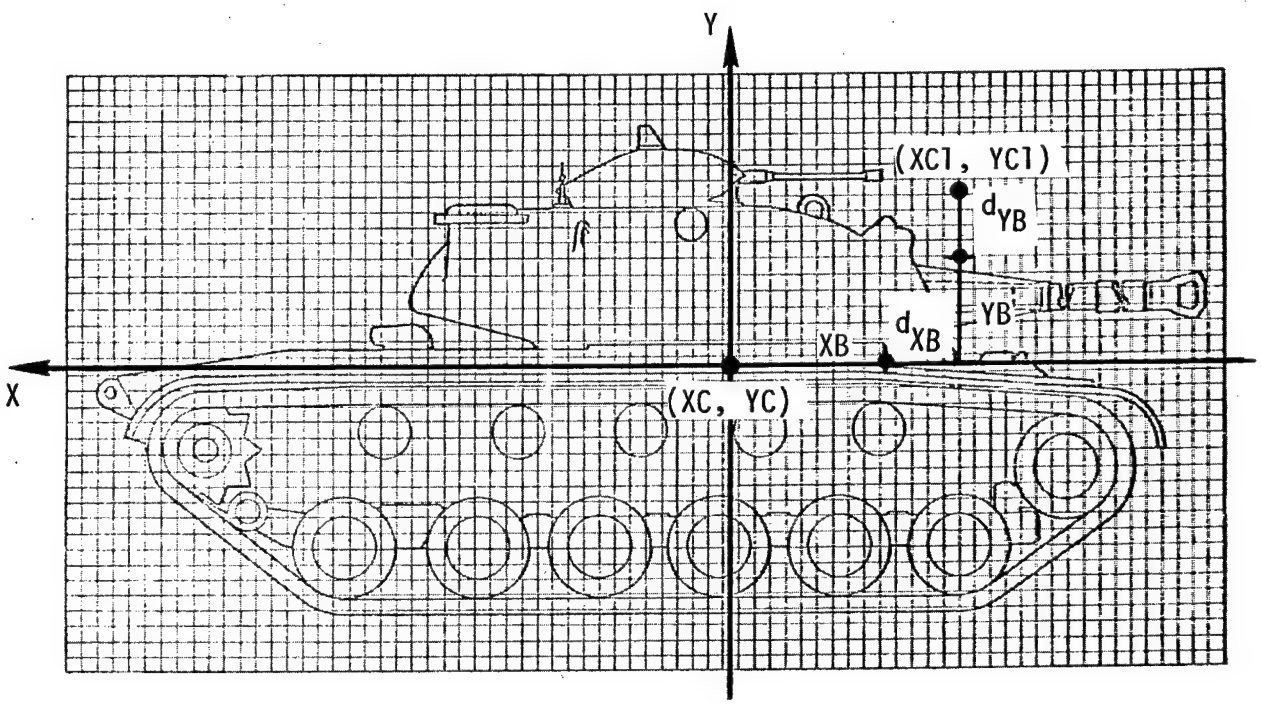
R1 = normal random deviate (nondimensional)

σ_{XB} = standard deviation of variable bias in horizontal direction (inches)

XC = intended horizontal aim center of target (inches)

XB = horizontal fixed bias for main rounds (inches)

YC1 = vertical center of impact for main rounds (inches)



(XC, YC) = INTENDED AIMPOINT

(XC1, YC1) = ACTUAL AIMPOINT

XB, YB = FIXED BIAS

d_{XB}, d_{YB} = VARIABLE BIAS SIGMA TIMES NORMAL RANDOM DEVIATE

Figure 2-1. Main Round System Delivery Errors

R2 = normal random deviate (nondimensional)

σ_{YB} = vertical standard deviation of variable bias (inches)

YC = intended vertical aim center of target (inches)

YB = vertical fixed bias for main rounds (inches)

The impact point of each round is a function of the ballistic dispersion which is defined by a probability distribution about the center of impact. The impact point of this round is determined by supplying a random normal deviate representing the random delivery error contribution to the ballistic dispersion probability distribution in accordance with the following equations. This is illustrated in Figure 2-2.

$$X1 = XC1 + (R3)(\sigma_{XR}) + (\sigma_{XL})(R4) \qquad (2\text{-}3)$$

$$Y1 = YC1 + (R5)(\sigma_{YR}) + (\sigma_{YL})(R6) \qquad (2\text{-}4)$$

where

X1 = horizontal impact point of main round (inches)

R3 = random normal deviate (nondimensional)

σ_{XR} = horizontal standard deviation of random error (inches)

σ_{XL} = horizontal standard deviation of lay error (inches)

R4 = random normal deviate (nondimensional)

Y1 = vertical impact point of main round (inches)

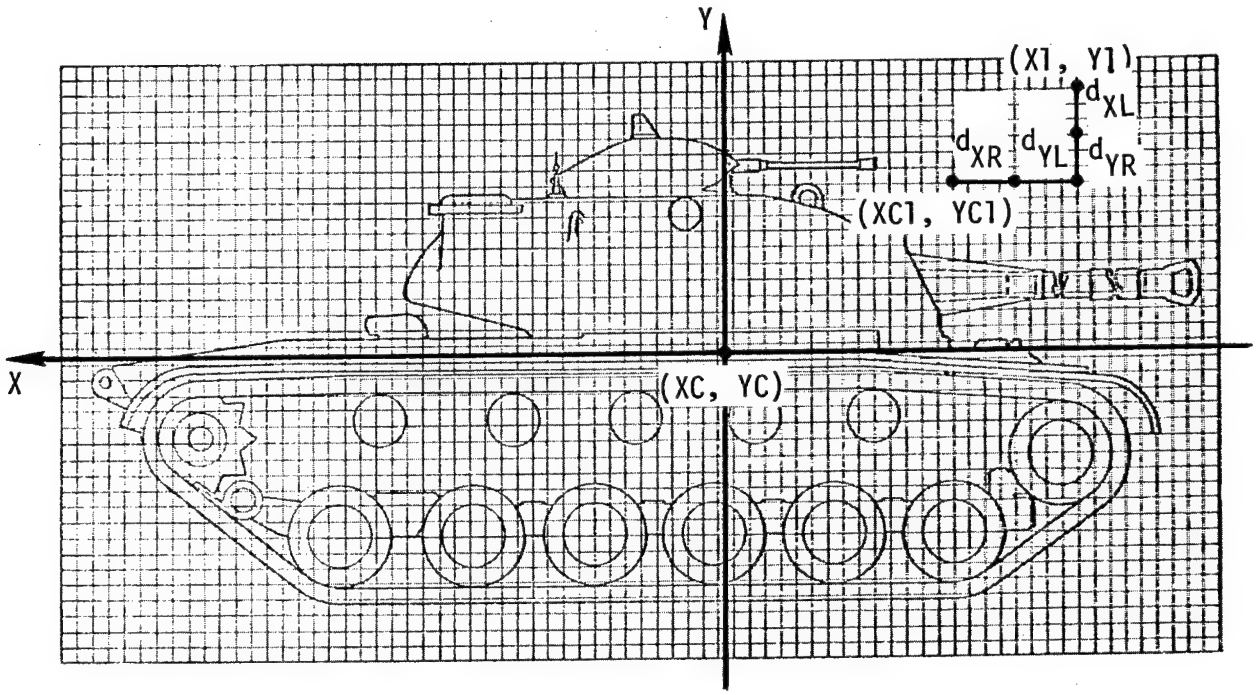
R5 = random normal deviate (nondimensional)

σ_{YR} = vertical standard deviation of random error (inches)

σ_{YL} = vertical standard deviation of lay error (inches)

R6 = random normal deviate (nondimensional)

All other terms have been previously defined.



(XC, YC) = INTENDED AIMPOINT

(XC1, YC1) = ACTUAL AIMPOINT

(X1, Y1) = IMPACT POINT

d_{XR}, d_{YR} = RANDOM ERRORS SIGMA TIMES NORMAL RANDOM DEVIATE

d_{XL}, d_{YL} = LAY ERRORS SIGMA TIMES NORMAL RANDOM DEVIATE

Figure 2-2. Main Round Random Delivery Errors

A test is performed to ascertain the location of the impact point relative to the target. If the round failed to hit the target and the miss is not sensed, or if the resulting impact on the target failed to meet requisite kill criteria, another round is fired, the impact point of which is negotiated as in Equations 2-3 and 2-4. If the miss of the round is sensed, as determined by drawing a suitable uniform random number, the aimpoint of the subsequent round is modified by supplying a random normal deviate to the following:

$$XC2 = XC1 - X1 + XC - (R7)(\sigma_{XS}) \tag{2-5}$$

$$YC2 = YC1 - Y1 + YC - (R8)(\sigma_{YS}) \tag{2-6}$$

where

XC2 = modified horizontal center of impact (inches)

R7 = random normal deviate (nondimensional)

σ_{XS} = horizontal standard deviation of sensing errors (inches)

YC2 = modified vertical center of impact (inches)

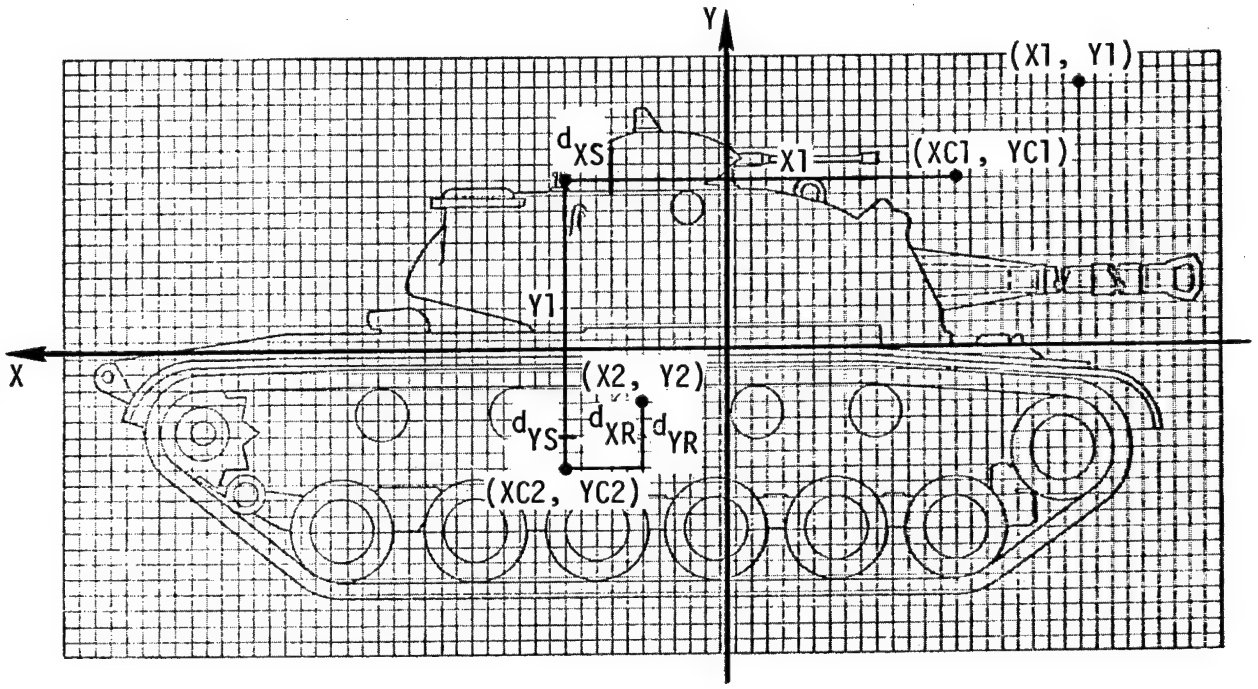
R8 = random normal deviate (nondimensional)

σ_{YS} = vertical standard deviation of sensing errors (inches)

All other terms have been defined. This transform is illustrated in Figure 2-3.

Round impact simulation continues as described in Equations 2-3 and 2-4 except that the lay factor is eliminated since the aimpoint has been modified by the incorporation of the effect of the sensing factor and that the modified aimpoint values replace the superseded aimpoint values.

The above sequence is repeated for each sample in determining main round target hits. Only the first hit is recorded for each sample and it updates the cumulative target hit probabilities of only those round numbers equal to or greater than the hitting round number. After the Monte Carlo sampling exercise has been completed, these cumulative target hit probabilities are divided by 9,604 (the total number of Monte Carlo trials) yielding the mean probability of hitting the target for a designated number of rounds fired.



(X1, Y1) = PREVIOUS IMPACT POINT

(XC1, YC1) = PREVIOUS AIMPOINT

(XC2, YC2) = MODIFIED AIMPOINT

d_{XS}, d_{YS} = SENSING ERROR SIGMA TIMES NORMAL RANDOM DEVIATE

(X2, Y2) = NEW IMPACT POINT

d_{XR}, d_{YR} = RANDOM ERRORS SIGMA TIMES NORMAL RANDOM DEVIATE

Figure 2-3. Delivery Errors, Sensed Miss Condition

Spotting Rifle Round

A small caliber rifle (e.g., 0.50 caliber) mounted on the carriage of, and ballistically matched to, a major artillery piece can be utilized as a round delivery assist device before firing a main round projectile. The procedure previously outlined for establishing the aim and impact points of the main round is repeated for the spotting rifle rounds. Once the spotting rifle round has achieved a target hit, the center of impact for the spotting round is adjusted by subtracting the target aimpoint coordinates. Then the aimpoint for the first main round fired is computed in accordance with the following equations, and is illustrated in Figure 2-4.

$$XC1 = (R9)(\sigma_{XB}) + XC + XB + XC3 \qquad (2\text{-}7)$$

$$YC1 = (R10)(\sigma_{YB}) + YC + YB + YC3 \qquad (2\text{-}8)$$

where

XC3 = adjusted spotting round horizontal center of impact (inches)

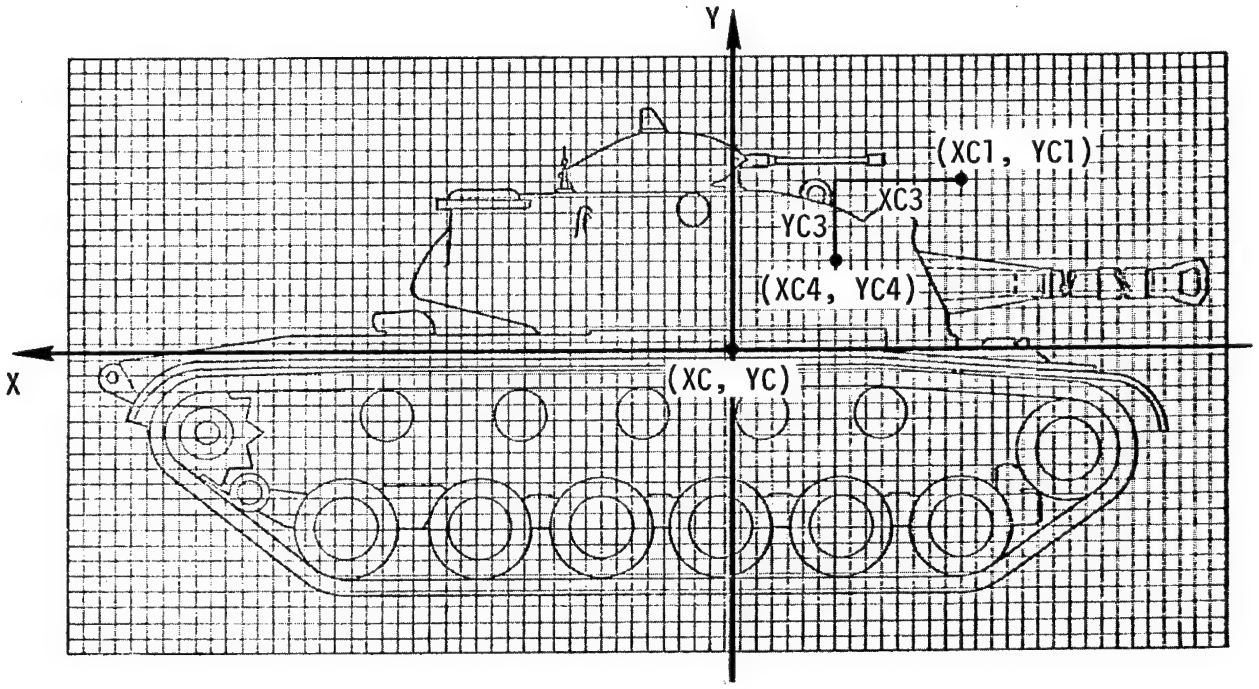
R9 = normal random deviate (nondimensional)

YC3 = adjusted spotting round vertical center of impact (inches)

R10 = normal random deviate (nondimensional)

All other terms have been previously defined.

The computational sequence for finding the main round impact points continues as described in Equations 2-3 and 2-4.



(XC, YC) = INTENDED AIMPOINT

(XC1, YC1) = ACTUAL AIMPOINT

(XC3, YC3) = ADJUSTED SPOTTING RIFLE ROUND AIMPOINT

(XC4, YC4) = FIRST MAIN ROUND AIMPOINT

Figure 2-4. Delivery Errors, Spotting Round Assist Condition

TIME-TO-KILL

A significant parameter which is monitored throughout the simulation model for each trial is the time-to-kill. In addition to the projectile time of flight, the time-to-kill reflects crew proficiency times. The exponential equation quantifying crew proficiency times is derived using empirical data from human factors studies and requires Monte Carlo sampling for its solution. All kill times exceeding 120 seconds are ignored in the compilation of time-to-kill data for each Monte Carlo trial since each of the elements of the time Pk array represents a 2-second interval from time 0 to 120 seconds.

Firing Time Environmental Factors

The estimation of the elapsed times for crews to fire rounds from their main armament in actual combat requires more than simply stating maximum or average rates of fire of the various weapons under test conditions generally tending to favor rapid fire. The objective is to estimate for each weapon of interest the distribution of times, not only average times, that crews would need to fire the weapon in a firing engagement. The approach representing times to fire aimed rounds in combat is based on the following basic definitions and related assumptions.

Firing Engagement

The firing engagement is defined as the firing of one or more rounds at a target. Although the main armament may be fired by the gunner or the commander of a crew, it is assumed that the gunner fires the weapon at the target indicated by the commander. The engagement begins when the commander issues the alert element "GUNNER" of the initial fire command. Times needed by the commander to detect, recognize, and identify the target are excluded from the engagement. However, any time that is subsequently needed to rotate the turret or to find the target is part of the engagement.

The first round fired at any target is normally assumed to be loaded before the engagement begins and all targets fired at are assumed to be seen by the gunner. Times discussed here do not apply to combat situations where the presence of a target is suspected but its actual location is not known. Subsequent rounds are considered fired if the target is not killed by the first round. Firing of rounds may stop for a variety of reasons, such as the target being killed or having moved to a new position where it cannot be effectively engaged.

Combat Conditions

Conditions representative of a combat situation in which a tank, for example, would fire at a target are defined as combat conditions. Some of the factors associated with combat conditions are:

(1) The time required to fire the first round at a target depends on whether or not the gunner can find and properly aim at the target indicated by the commander. Acquisition of the target by the gunner usually presents no problem under demonstration or test situations, but in the field, factors such as obscuration and the degree of contrast between the target and its background can influence the time required by the gunner to see and aim at the target.

(2) The gunner's care in achieving his fine lay for firing is related to the apparent size of his target. The degree of care that he chooses to exercise in making a fine lay for firing especially affects the first round firing time.

It is well known that there are interactions between factors affecting hit probabilities and factors influencing firing times. Such interactions obviously must be taken into account to ensure that firing times are compatible with corresponding weapon delivery accuracy estimates. From the viewpoint of how quickly a tank crew can fire rounds, combat conditions are categorized in the following three ways:

(1) Favorable conditions are combat conditions which permit all crews to perform necessary tasks as rapidly as they can. Time needed by various crews to fire rounds still varies according to their proficiency. Examples of factors making conditions favorable would be the absence of obscuration, resulting in the gunner experiencing no difficulty in finding his target, and a large apparent target size, making the exercise of great care for the fine lay unnecessary.

(2) Intermediate conditions are combat conditions midway between favorable and severe. Such conditions are thought of as average.

(3) Severe conditions are combat conditions which limit to the maximum extent the ability of all crews to perform necessary tasks. Time required to fire rounds still varies with crew proficiency. Obscuration caused by smoke and dust could make the gunner's target acquisition task very difficult and a small apparent target size could influence the gunner to make an extremely careful fine lay.

It is difficult to forecast how frequently the various conditions would occur in actual combat. Nevertheless, favorable conditions would probably occur less frequently in combat than in the tests conducted to obtain firing time data or for crew qualification purposes. Unless particular efforts to balance combat conditions are made, these tests tend to be conducted under conditions that can be considered favorable. However, some exercises conducted have involved conditions that could be judged intermediate and perhaps border on severe. Note that, since absolute precision is not involved in these explanations, informed judgment will play a large role in attempts to relate particular data or performance levels to an associated set of environmental conditions.

Crew Proficiency

Crew proficiency is defined as the level of proficiency that results from the tank crew's basic ability and the training from which it has benefited. In this discussion, proficiency is considered exclusively from the viewpoint of its influence on how quickly crews can fire rounds. Crew proficiency is categorized in the following ways:

(1) Best crew rating denotes the maximum proficiency that any crew can be expected to attain. Crews in this category are the exceptionally fast crews.

(2) Good crew rating denotes a level of proficiency midway between that of a best crew and an acceptable crew.

(3) Acceptable crew rating denotes the minimum level of proficiency that all crews can be expected to attain and surpass.

Here again, absolute precision is not possible and determinations associated with crew proficiency require judgment. The proficiency associated with best crews, for instance, under any particular environmental conditions, is intended to correspond to a level achievable only by crews with maximum inherent ability and maximum feasible peacetime training. Most crews cannot achieve this status no matter how much training they might undergo, and crews with the greatest ability may still fail to qualify as best if training opportunities sufficient to develop and maintain their proficiency are not provided. The level of performance associated with acceptable crews, again under particular environmental conditions, is intended to be a lower bound to acceptable performance. This status is achievable by crews with the least inherent ability if they are provided adequate training opportunities. Note that, since the level of proficiency demonstrated by any crew in particular environmental circumstances depends on both ability and training, either factor can compensate for failings.

Aimed Round Time Factors

The program also utilizes time factors for aimed rounds including first round firing time, flight time, fixed and variable times, median times, and minimum times to compile time-to-kill data. These factors are discussed in the paragraphs that follow.

First Round Firing Time

This is defined as the time elapsing between target recognition and firing of the first round assuming that the decision to engage the target follows target recognition without any delay. Operations involved in firing of the first round include, as applicable, the following:

(1) Target recognition by the gunner.

(2) Slewing of the weapon.

(3) Ranging, which may be done with equipment such as a rangefinder, or by visual estimation of the range to the target.

(4) Laying of the weapon.

Note that some of these operations can be carried out simultaneously.

Loading of the first round may be included or excluded. In the latter case, the appropriate type of round is considered already loaded before recognition of the target.

Flight Time

Flight time is the time that elapses between the time a round begins to be propelled forward in the gun and the time it reaches the range of the target.

Subsequent Round Firing Time

This is defined as the time elapsing between firing of any round and firing of the next round against the same target. Subsequent round firing time involves, as applicable, the following:

(1) Flight time of the previous round.

(2) Round loading.

(3) Relaying of the weapon, which may or may not reflect efforts to improve the aimpoint with reference to the aimpoint used for the previous round.

Fixed Times

Fixed time is defined as that portion of total firing time that is independent of environmental conditions, crew skill, level of training, or other causes of variation in firing time performance. This time is frequently associated with mechanical operations such as automatic ramming. Fixed time may equal zero.

Variable Times

Variable time is defined as that component of total first or subsequent round firing time that needs to be represented by a distribution of times, rather than by a fixed time component. On any particular firing occasion, total firing time equals the sum of the applicable fixed time component and a particular time from the distribution describing the variable time component. Variable time is tied to human operations and generally will not equal zero, because there are so many causes of variation that are not controllable.

Median Times

Median times of the distributions apply to the variable component of both the first round firing time and the subsequent round firing time. Median time can be defined as the particular time which is greater than half the time represented by the corresponding distribution and smaller than the remaining half.

For the special case where a logarithmic-normal distribution is fitted to data consisting of N particular times, the median time is the N^{th} root of the product of all times in the set of data considered. Alternatively, for this special case, the median time corresponds to the logarithm equaling the arithmetic mean of the N logarithms corresponding to the times constituting the basic data. Detailed studies made many years ago in the U.S. established that logarithmic-normal distributions seemed to correspond more closely than other known distributions to test data obtained for tank weapons of interest at the time. Distributions of this type are still considered useful to represent variable components of firing times for weapons of current concern.

Variability Factors

Variability factors indicate to what extent the times represented by logarithmic-normal distributions vary with reference to the applicable median times. A standard deviation (based on calculations with natural logarithms) of about 0.5 has been found to apply consistently and is normally used, unless there is a specific reason for doing otherwise.

The mathematical discussion that follows should facilitate understanding logarithmic-normal distributions based on a standard deviation of 0.5.

Let time data corresponding to a particular operation and associated conditions be v1, v2,..., vN in seconds. Let V1, V2,..., VN be logarithms of v1, v2,..., vN. Assume V1, V2,..., VN are normally distributed with median, M, and standard deviation, S. Let m = antilog(M). Let g(v) = cumulative probability that a particular crew performs operation in v or less seconds. Let V = log (v).

$$g(v) = \int_{-\infty}^{\frac{V-M}{S}} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}u^2\right) du \qquad (2\text{-}9)$$

where

$$\frac{V - M}{S} = \frac{\log(v) - \log(m)}{S} = \log\left[\left(\frac{v}{m}\right)^{1/S}\right]$$

Everything that precedes is valid for both natural logarithms and logarithms to the base 10, provided one or the other is consistently employed. From this point on, only natural logarithms will be considered because computer programs developed for effectiveness calculations are based on their use.

The particular value of 0.5 for the standard deviation S is used in what follows. Consider time v = 2m:

$$\frac{V - M}{S} = \ln\left[2^{(1/0.5)}\right] = \ln(4) = 1.386$$

$$g(v) = 0.92$$

Also, it is easily shown that if v = m/2, g(v) = 0.08. Consequently, a general rule is that for S = 0.5, all but about 1/6 of the times represented by a logarithmic-normal distribution are bracketed between half the median and twice the median. Likewise, consider time v = 3m:

$$\frac{V - M}{S} = \ln 3^{(1/0.5)} = \ln(9) = 2.197$$

$$g(v) = 0.98$$

where

v = m/3, g(v) = 0.02

It is then evident that all but about 1/25 of the times in a logarithmic-normal distribution for which S = 0.5 lie between a third of the median and three times the median. Similar calculations can be made to help one understand any numerical value of the variability factor S.

Minimum Times

Minimum time is defined as the least time considered possible. Such a least time, if one other than zero is specified, overrides any unrealistically shorter times that may be implied by a particular time distribution used.

The data base used to establish firing time estimates for various weapons, yields two points of interest:

(1) Reliance is not placed on any one source of data. A balanced viewpoint stripped of biases that an analyst could form as a result of specific limited experiences is required.

(2) Data from older sources need not be discarded as newer weapons become of principal interest. Several relationships can be useful even after weapons used to obtain underlying data become obsolete.

As in the case of delivery accuracy estimates, the construction of firing times for a specific weapon requires a thorough understanding and definition of the system being examined. This means knowledge of the weapon in isolation and in a vehicle. Times of flight, slew rates, target designation facilities, fire control equipment, standard operating procedures, breech operation, loading devices, round weights, and round sizes are some of the factors which can affect firing time estimates. Tank and target movement, in conjunction with the assumed conditions and system definition, also affect firing times. The bulk of information available on firing times is for stationary tanks firing at stationary targets, but firing time estimates should be made for other tank target movement conditions as part of this assessment.

Main Round

At the outset of each sample simulation run, the initialized time of zero is augmented by the time of flight of the main round. Henceforth, the time is updated by crew proficiency factors which indicate how quickly crews can fire rounds as a result of their training and basic ability. Inherent in the concept of crew proficiency would be such elements as target acquisition time, aiming time, and firing time.

The following exponential equation derived using empirical data from human factors studies requires Monte Carlo sampling for the solution of a time factor for variable crew proficiency.

$$HWM = (XM)\ \exp[(R9)(ST)] \tag{2-10}$$

where

HWM = incremental time factor for variable crew proficiency (seconds)

XM = variable median time (seconds)

R9 = random normal deviate (nondimensional)

ST = slope of time distribution

If HWM is less than a minimum reasonable variable time to accomplish the firing, the predetermined prescribed minimum time to fire is used for HWM. The time of round impact is then computed in accordance with the equation:

$$T_I = T_C + HWM + TFS \tag{2-11}$$

where

T_I = time of round impact (seconds)

T_C = current accumulated time (seconds)

TFS = fixed median time (seconds)

All other terms have been defined.

For firing subsequent rounds, the sequence returns to execute Equation 2-10 and continues as described. When a target kill has been accomplished for a given kill criterion, the time of kill is matched to the corresponding time interval element in the kill array. Only the first kill is recorded for each sample for a given kill criterion. It updates the cumulative target kill probabilities of only those times equal to or greater than the computed kill time. After the Monte Carlo sampling exercise has been completed, each cumulative target kill

probability is divided by 9,604 (the total number of trials), yielding a mean probability of killing the target at a specific time interval less than or equal to 120 seconds.

Spotting Rifle Round

The procedure previously outlined for establishing the time-to-kill target for the main rounds is followed for the spotting rounds to register the target hit time which is then added to the flight time of the first main round. The computational sequence for finding the time to target kill for the main rounds then continues as described in Equations 2-10 and 2-11.

MEAN VALUES

The mean target Pk data, the mean time Pk data, the mean target Ph data, and the mean time Ph data are computed by dividing the number of samples into the accumulated element values of the applicable arrays.

The arithmetic mean is defined as the sum of all the observations divided by the total number of observations.

$$\bar{\ell} = \frac{\sum_{i=1}^{n} \ell_i}{n} \qquad (2\text{-}12)$$

where

$\bar{\ell}$ = mean value of n observations

ℓ_i = i*th* observation

n = total number of observations

CASE ROUNDS FIRED

The average number of rounds fired to achieve a kill for each case is computed in accordance with the equation:

$$AV1 = \sum_{i=1}^{r} i\ (P_i - P_{i-1}) \qquad (2\text{-}13)$$

where

AV1 = average number of rounds fired to achieve a kill for a designated case (excluding non-killing trials)

r = number of main rounds fired per sample

P_i = mean target Pk after firing i rounds

i = intermediate factor representing the number of rounds fired

The above equation is applicable only if a kill is achieved for a designated case on each of the 9,604 Monte Carlo trials. Otherwise, computation of the average number of rounds fired to achieve a kill for a given case is accomplished utilizing not only those rounds fired for non-killing trials but also an additional error estimate based upon the process of extrapolation to the limit.

In addition to the specified number of rounds fired per trial as dictated by the input data, the effectiveness of five succeeding rounds is estimated based upon the mean results of the last five rounds fired for all the sample trials. The estimated scaled data are used in the computation of the average number of rounds fired per case in accordance with the equation:

$$AV2 = \sum_{i=r+1}^{r+5} i\ (P_i - P_{i-1}) + AV1$$

where

$$AV2 = rP_{r+5} - rP_r + 5P_{r+5} - (P_r + P_{r+1} + P_{r+2} + P_{r+3} + P_{r+4}) + AV1$$

Introducing the scaling factor of $\left(\frac{1 - P_r}{P_r - P_{r-5}}\right)$ = SF such that

$P_i = \frac{1 + P_{i-5}(SF)}{1 + SF}$ for $r \leq i \leq r + 5$, converting terms, and letting

$P_{r+5} = 1.0$, then:

$$AV2 = r(1 - P_r) + 5 - \left[\frac{5 + (SF)\sum_{i=r-5}^{r-1} P_i}{(1 + SF)}\right] + AV1$$

$$AV2 = r(1 - P_r) + \left[\frac{5(SF) - (SF)\left(\sum_{i=r-5}^{r-1} P_i\right)}{(1 + SF)}\right] + AV1$$

The value of the denominator (1 + SF) is assumed to be unity, therefore,

$$AV2 = r(1 - P_r) + \left(\frac{1 - P_r}{P_r - P_{r-5}}\right)\left(5 - \sum_{i=r-5}^{r-1} P_i\right) + AV1 \qquad (2\text{-}14)$$

where

AV2 = average number of rounds fired to achieve a kill for a designated case (including non-killing trials)

All other terms have been previously defined.

CLOSED FORM SOLUTION

Although the basic program methodology of resolving the system and random errors in determining projectile impact locations is accomplished by Monte Carlo sampling, a closed form solution of a single main round is performed for each new impact data set so that comparable Monte Carlo results can be reviewed for agreement.

In describing a weapon's accuracy against a point target, or its ability to hit where it is aimed, it is generally assumed that the errors in elevation and azimuth are distributed according to the normal or Gaussian law. The dispersion of a fired round is a function of the ballistic characteristics of the particular projectile configuration and of the meteorological conditions existing at the time and place of the weapon firing. Dispersion is considered a random error. The effect of the aiming error is inherently biased in some direction and is regarded as a systematic error. The combined distribution representing the distribution of impact points in an area is a normal distribution in two dimensions.

The assumption that the distribution of impact points is normal is predicated upon the reasonable agreement found between prediction based upon the assumption of normality and the data of actual impact distributions. The presumption that the impact distribution is generated as the sum of a number of independent random variables suggests the applicability of the central limit theorem which would imply that the distribution of the sum would be approximately normal.

The probability of a single main round hitting the target and the probability of a single main round hitting the target given a sensed miss are computed at the outset of the JMEM/SS Model For Direct Fire Computer Program utilizing the error function associated with the normal curve. Since the weapon errors in the horizontal and vertical directions are distributed normally and occur independently, the resulting distribution of errors in the two planes is a bivariate normal distribution which can be described by the function:

$$PA_i = \frac{1}{2\pi\sigma_X\sigma_Y} \int_{A_i}\int \exp - \left(\frac{X^2}{2(\sigma_X)^2} + \frac{Y^2}{2(\sigma_Y)^2} \right) dX\ dY \qquad (2\text{-}15)$$

where

PA_i = probability impact point will lie in area A_i

σ_X = horizontal standard deviation of impact error for a single main round (inches)

σ_Y = vertical standard deviation of impact error for a single main round (inches)

A_i = i*th* target grid cell area

X = represents horizontal (X) target coordinate

Y = represents vertical (Y) target coordinate

Equation 2-15 is used to compute the target cell hit probabilities for a single main round given a sensed miss. The computation can be used for either a single main round or, if the option is exercised, for a single main round with a spotting rifle round assist. The hit probabilities for all the target grid cells are summed to include the entire target form in accordance with the equation:

$$Ph = \sum_{i=1}^{a} PA_i \qquad (2\text{-}16)$$

where

Ph = probability of hitting target with a single round

a = number of target cells

All other terms have been previously defined.

In order to compute the sum of standard deviations, the root-sum-square combination is executed to determine the standard deviation of impacting errors in the horizontal and vertical directions for a single main round, for a single main round given a sensed miss, and for a single main round with a spotting round assist.

Single Main Round

Assuming that the random errors, variable bias, and lay errors for a single main round are independent and normally distributed,

$$\sigma_X = \sqrt{\sigma_{XR}^2 + \sigma_{XB}^2 + \sigma_{XL}^2} \qquad (2\text{-}17)$$

$$\sigma_Y = \sqrt{\sigma_{YR}^2 + \sigma_{YB}^2 + \sigma_{YL}^2} \qquad (2\text{-}18)$$

where

σ_{XR} = standard deviation of horizontal random error for main rounds (inches)

σ_{XB} = standard deviation of horizontal variable bias for main rounds (inches)

σ_{XL} = standard deviation of horizontal lay error for main rounds (inches)

σ_{YR} = standard deviation of vertical random error for main rounds (inches)

σ_{YB} = standard deviation of vertical variable bias for main rounds (inches)

σ_{YL} = standard deviation of vertical lay error for main rounds (inches)

All other terms have been previously defined.

Single Main Round Given Sensed Miss

Assuming that the sensing errors and random errors for a single main round are independent and normally distributed:

$$\sigma_A = \sqrt{\sigma_{XS}^2 + 2(\sigma_{XR})^2} \qquad (2\text{-}19)$$

$$\sigma_B = \sqrt{\sigma_{YS}^2 + 2(\sigma_{YR})^2} \qquad (2\text{-}20)$$

where

σ_A = horizontal standard deviation of impact error for a single main round given a sensed miss (inches)

σ_{XS} = standard deviation of horizontal sensing error for main rounds (inches)

σ_B = vertical standard deviation of impact error for a single main round given a sensed miss (inches)

σ_{YS} = standard deviation of vertical sensing error for main rounds (inches)

All other terms have been defined.

Single Main Round with a Spotting Round Assist

Assuming main round impact sigma and the sensing errors, lay errors, and variable bias from a spotting rifle round are independent and normally distributed:

$$\sigma_{X1} = \sqrt{\sigma_X^2 + [.5\ (\sigma_{XS1} + \sigma_{XL1})]^2 + \sigma_{XR1}^2} \qquad (2\text{-}21)$$

$$\sigma_{Y1} = \sqrt{\sigma_Y^2 + [.5\ (\sigma_{YS1} + \sigma_{YL1})]^2 + \sigma_{YR1}^2} \qquad (2\text{-}22)$$

where

σ_{X1} = horizontal standard deviation of impact error for a single main round with spotting round assist (inches)

σ_{XS1} = standard deviation of horizontal sensing error for spotting rounds (inches)

σ_{XL1} = horizontal standard deviation of lay error for spotting rounds (inches)

σ_{XR1} = standard deviation of horizontal random error for spotting rounds (inches)

σ_{Y1} = vertical standard deviation of impact error (inches)

σ_{YS1} = vertical standard deviation of vertical sensing error for spotting rounds (inches)

σ_{YL1} = vertical standard deviation of lay error for spotting rounds (inches)

σ_{YR1} = standard deviation of vertical random error for spotting rounds (inches)

All other terms have been previously defined.

SECTION III

CONCEPTUAL FLOWCHARTS

This section contains conceptual flowcharts for the JMEM/SS Model for Direct Fire Computer Program. A flowchart for each significant section follows a narrative keyed to the flowchart by step numbers. Steps are indicated on the flowcharts by numbers enclosed in hexagons.

These flowcharts provide an effective pictorial summary of the computational steps of this program. A more detailed level of discussion is provided in Section IV, Simulation Model.

MAIN ROUTINE

The MAIN Routine is used to locate the impact points of the main and spotting rifle rounds and to compute the target probability of kill, the target probability of hit, the time probability of kill, and the time probability of hit data.

The following description is an outline of the flow of the MAIN Routine. The description is keyed to the conceptual flowchart, Figure 3-1, by the numbers enclosed in hexagons.

(1) Execution is begun by calling Subroutine INPUT to read and write the input data for the 9,604 Monte Carlo trials. Subroutine SSHOT is called to compute and write a closed form solution of a single main round hit probability and of a single main round hit probability given a sensed miss before initializing selected arrays in preparation for later processing.

(2) After the Monte Carlo trial loop is entered, Subroutine NRAN31 is called to provide the random normal deviates necessary to compute the impact points and to update the time-to-kill for either the spotting round or the main round. If the target is not hit, the next round is fired, or the sample loop is re-entered if there are any remaining Monte Carlo trials to be negotiated. If a target hit has been achieved by a spotting rifle round, the main round loop is entered.

(3) The kill criteria loop for the main round is entered. When the target hit achieves the first target kill of each sample for the criterion under consideration, the cumulative target Pk, and the cumulative time Pk arrays are updated.

(4) If there are no more rounds to be fired for a sample and all the Monte Carlo trials have been completed, the mean values of the cumulative target Pk and cumulative time Pk arrays are computed and written.

(5) If the number of main rounds fired per sample is not equal to one, Subroutine KILRAT is called to compute and write the average number of main rounds fired per case. Upon return from Subroutine KILRAT, either a new input data set is read or program execution terminates.

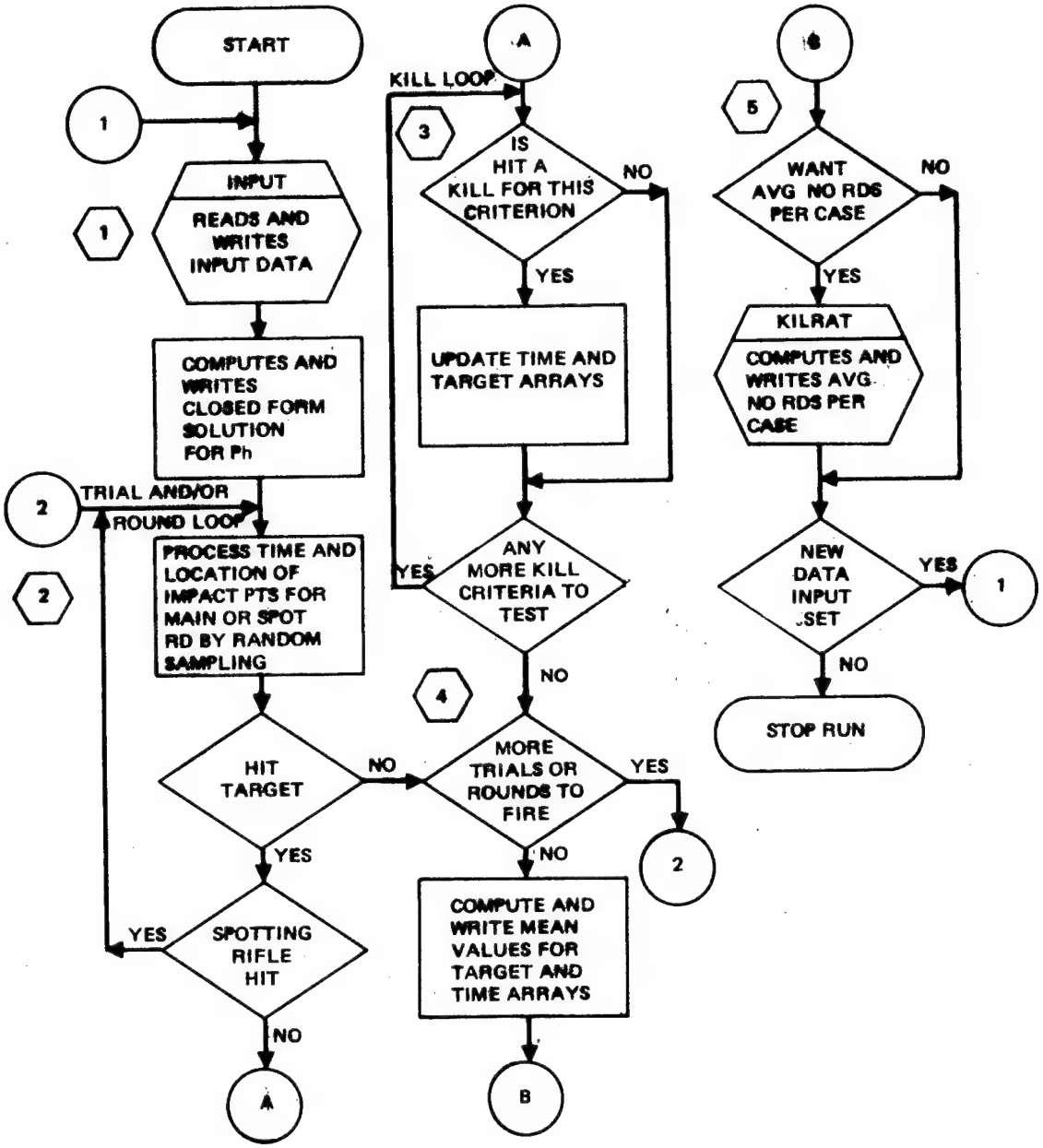


Figure 3-1, Flowchart, Main Routine

SUBROUTINE KILRAT

This subroutine is used to compute and write the average number of main rounds fired for each case (which represents each given kill criterion and the target hit data). The following description is an outline of the flow of Subroutine KILRAT. The description is keyed to the conceptual flowchart, Figure 3-2, by the numbers enclosed in hexagons.

⟨1⟩ The case loop is entered and the round loop is executed to compute the average number of rounds fired for a given case.

⟨2⟩ If a kill occurred within the set number of rounds fired for a given case for each sample, the average number of rounds fired for that case is written. Otherwise, the computation of the average number of rounds fired for that case, including not only those rounds fired on non-killing trials but also an estimated extrapolated factor, is performed before writing the results. Control returns to the calling routine after completion of all the cases.

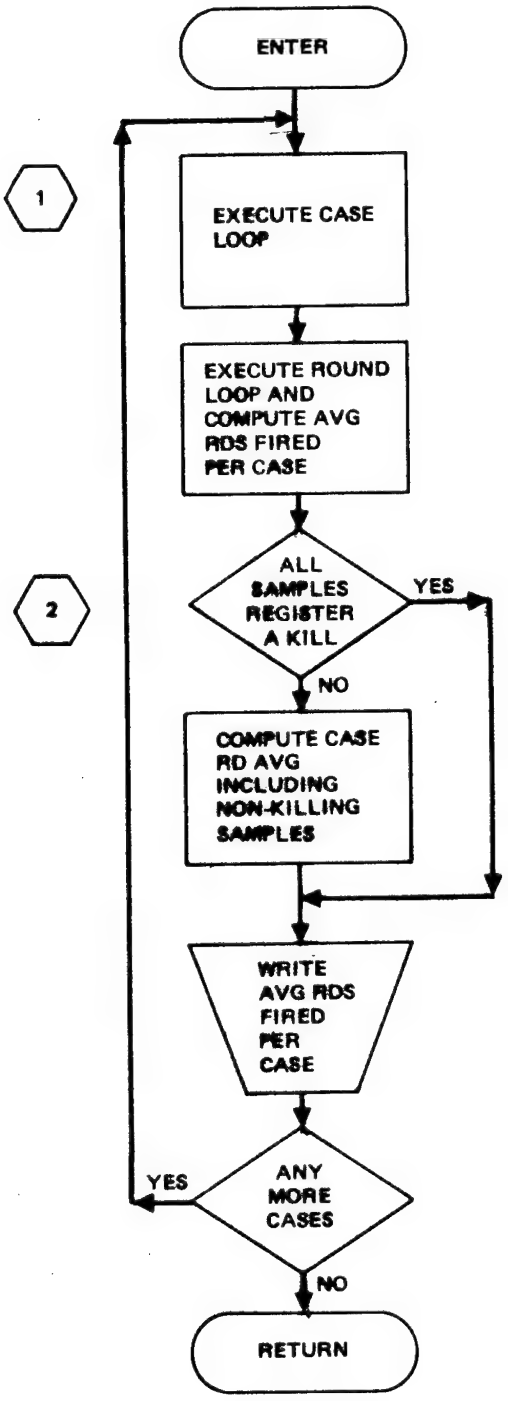


Figure 3-2. Flowchart, Subroutine KILRAT

SUBROUTINE SSHOT (PCH, PCH1)

This subroutine is used to compute the probability of hitting the target for a single main round and the probability of hitting the target for a single main round given a sensed miss by using a closed form solution. The following description is an outline of the flow of Subroutine SSHOT. The description is keyed to the conceptual flowchart, Figure 3-3, by the numbers enclosed in hexagons.

(1) The standard deviation of the impact error for a main round and the standard deviation of impact error for a main round given a sensed miss are computed. If spotting rifle round data is to be included, these standard deviations are appropriately modified.

(2) All grid cells describing the target form are identified in order to compute and to appropriately sum the probabilities of a single round hitting these designated target cells by using the cumulative normal distribution function.

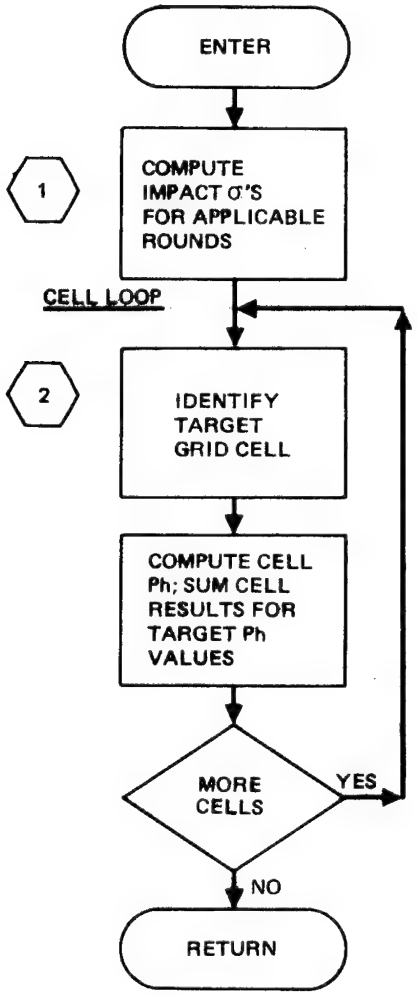


Figure 3-3. Flowchart, Subroutine SSHOT

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SECTION IV

SIMULATION MODEL

The JMEM/SS Model for Direct Fire Computer Program is comprised of a MAIN Routine and six subprograms. This section describes how each of these elements of the program is used to implement the Mathematical Model described in Section II. The subprograms are described one at a time; the purpose of each subprogram is defined, and the function of each group of statements within the subprogram is described.

After the initial data set pertaining to all of the Monte Carlo sample trials is read by Subroutine INPUT, the target grid and Pk arrays are set up. Subroutine SSHOT is called to compute a closed form solution of the probability of hitting the target for a single main round and the and the probability of hitting the target for a single main round given a sensed miss.

Subroutine NRAN31 and Function RANDOM are utilized in applying a Monte Carlo sampling technique in determining target kills, round aimpoints, round impact points, and the time-to-kill values. The results are generated in the MAIN Routine from 9,604 Monte Carlo trials which yield mean target Pk data, mean time Pk data, mean target Ph data, mean time Ph data, and the average number of rounds fired per case.

In the following paragraphs, the individual FORTRAN statements that make up the Simulation Model include references to Section II, Mathematical Model. These references consist primarily of the boxed equations that gave rise to the FORTRAN statements, but not their derivations. The same boxed equations can be found in the Mathematical Model with their derivations. The number enclosed in parentheses next to each equation is its identifying number in Section II. In addition, comment statements appearing in the source listing are included in the Simulation Model for the sake of completeness.

Several subprograms call COMMON and DIMENSION FORTRAN statements, whose purpose is to set aside arrays to store values of the variables appearing in the statements. The definition of the variable names, as well as the variables in the subroutine call statements, are provided in the List of Abbreviations and Symbols at the end of this section.

MAIN ROUTINE (1 of 13)

This program is used to locate the impact points of the main and spotting rifle rounds, to monitor the time-to-kill, and to compute target probability of kill, target probability of hit, time probability of kill, and time probability of hit data.

The program is begun by execution of the statements

```
C*************************************************************************
C
C    JMEM/SS MODEL FOR DIRECT FIRE
C
C    MAIN PROGRAM
C    PURPOSE
C    LOCATES IMPACT POINTS OF MAIN AND SPOTTING RIFLE ROUNDS; MONITORS
C    THE TIME TO KILL; COMPUTES PK AND PH TARGET DATA AND PK AND PH TIME DATA
C
C*************************************************************************
C
C    SUBPROGRAMS REQUIRED
C    INPUT- READS INPUT DATA.
C    KILRAT- COMPUTES AND WRITES THE AVERAGE NUMBER OF MAIN ROUNDS FIRED
C    PER CASE.
C    NRAN31- PROVIDES NORMAL DEVIATES FOR MONTE CARLO SAMPLING
C    RANDOM-UNIFORM RANDOM NUMBER GENERATOR.
C    SSHOT- COMPUTES PH FOR A SINGLE MAIN ROUND AND PH FOR A SINGLE ROUND
C    GIVEN A SENSED MISS USING A CLOSED FORM SOLUTION.
C
C*************************************************************************
C
      DIMENSION PK(3000 ,8),AX(201),AY(51 ),Z(19 ,9),C(8),Z1(61 )
      COMMON PK,AX,AY,SIGXR,SIGYR,SIGXB, SIGYB,SIGXS,SIGYS,PROBS,XB,YB,
     1XC,YC,REL,TF1,TFS,XM1,XM2,YDEF,NOPT1,NRDS,NX,NY,FLT,ST1,ST2,AMT1,
     2AMT2,IK(50,200),Z,Z1 ,AKIL(61,9),SIGXL,SIGYL,RELF
     3,SIGXS1,SIGYS1,SIGXB1,SIGYB1,SIGXR1,SIGYR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
      COMMON/ RANDM/I1
C
```

which are used to allocate storage for arrays and to provide for the exchange of data between the MAIN Routine and the remainder of the program. The random number seed is initialized, and Subroutine INPUT is called to read and write the input data by execution of the statements

```
C    SET I1= TO ANY ODD NUMBER FOR RANDOM SEED.
C
      I1=11111111
C
C    READ INPUT
C
 2    CALL INPUT
```

The statements

```
C
C    COMPUTE PROBABILITY OF HIT OF FIRST ROUND AND PROBABILITY OF HIT GIVEN
C    A SENSED MISS IN A CLOSED FORM SOLUTION AND WRITE RESULTS.
C
```

MAIN ROUTINE (2 of 13)

```
      CALL SSHOT(PCH,PCH1)
      WRITE(6,60) PCH,PCH1
 60   FORMAT(/31H PROB. OF HIT OF FIRST ROUND = ,F16.7,/28H PROB. OF HIT
     1/SENSED MISS = ,F16.7)
```

are used to call Subroutine SSHOT in order to compute a closed form solution, i.e. without utilizing a Monte Carlo sampling technique, of a single main round target hit probability and of a single main round target hit probability given a sensed miss. These results, which should be comparable to subsequent Monte Carlo derived values for the same target/weapon parameters, are written before the Monte Carlo sample size, the time-to-kill array, and the mean Pk array are initialized by the execution of the statements

```
C
C    INITIALIZE SAMPLE SIZE.
C
      NSAMP=9604
C
C    INITIALIZE TIME ARRAY AND PROBABILITY ARRAY.
C
      DO95J=1,6
      DO158I=1,61
 158  AKIL(I,J)=0.
      DO 95 I=1,NRDS
 95   Z(I,J)=0.
```

The statements

```
C
C    PRINT OUT SAMPLE SIZE.
C
      WRITE(6,62)NSAMP
C
C    START SAMPLING
C
      TH12=0
      TH13=0
      DO 99 I=1,NSAMP
C
C    INITIALIZE VARIABLES FOR EACH SAMPLE.
C
      SUMCAS =0.
      XC1=0.
      YC1=0.
      TH10=0
      TH11=0
      T=0.
      THW=0
      DO94J=1,8
 94   C(J)=0.
```

are used to write the sample size, to enter the loop of the 9,604 Monte Carlo samples, and to initialize the following variables for each sample: the personnel casualty counter, the center of impact of the main or

spotting rounds, the main round flag, the spotting rifle round counter, the time-to-kill, the first main round hit flag, and the kill flag array.

The statements

```
C
C    IF ONLY MAIN ROUNDS CONSIDERED GO TO 201.
C
      IF(NOPT1.NE.2)GOTO201
      CALL NRAN31(R1,R2)
C
C    SET T TO TIME OF FLIGHT OF ONE SPOTTING RIFLE SHOT.
C
      T=FLT1
C
C    XC1,YC1 IS CENTER OF IMPACT FOR FIRST ROUND OF SPOTTING RIFLE SHOTS.
C
      XC1=R1*STGXB1+XC+XB1
      YC1=R2*STGYB1+YC+YB1
```

are used to check the flag governing program options. If NOPT1 does not equal two, the program considers only main rounds and control is transferred to Statement 201. If NOPT1 equals two, the time-to-kill is updated by the time of flight of a spotting rifle round, and Subroutine NRAN31 is called to provide the random normal deviates needed to compute the horizontal and vertical coordinates of the center of impact for the first spotting rifle round.

The statements

```
      FAC=1.
C
C    DRAW NORMAL DEVIATES FOR RANDOM AND LAY ERRORS OF SPOTTING RIFLE.
C
 200  CALL NRAN31(R1,R2)
      CALL NRAN31(R3,R4)
C
C    TH11 IDENTIFIES THE SPOTTING RIFLE ROUNDS.
C
      TH11=TH11+1
C
C    DRAW NORMAL DEVIATES FOR TIME FOR SPOTTING RIFLE.
C
      CALL NRAN31(T1,T2)
C
C    FOR FIRST ROUND TIME OF SPOTTING RIFLE GO TO 210.
C
      IF(TH11.EQ.1)GOTO210
C
C    FOR SUBSEQUENT ROUND TIMES.
C
      HWM=XM21+EXP(T1*ST21)
      IF(HWM.LE.AMT21) HWM=AMT21
      T=T+HWM+TFS1
```

MAIN ROUTINE (4 of 13)

```
      GOTO211
 210  HWM=XM11*EXP(T1*ST11)
      IF(HWM.LE.AMT11) HWM=AMT11
      T=T+HWM+TF11
 211  CONTINUE
C
C    IMPACT POINT FOR THIS SPOTTING RIFLE SHOT.
C
      X1=XC1+R1*SIGXR1+R3*SIGXL1*FAC
      Y1=YC1+R2*SIGYR1+R4*SIGYL1*FAC
C
C    GO SEE IF THIS SHOT HIT.
C
      GOTO160
```

are used to compute the impact point and to update the time-to-kill the target for the spotting rifle rounds after calling Subroutine NRAN31 in order to furnish the random normal deviates for the computations. Control is then transferred to Statement 160 to ascertain if the spotting round impact point lies within the extremities of the target area.

The statements

```
C
C    DRAW RANDOM DEVIATES FOR VARIABLE BIAS ERRORS FOR FIRST MAIN ROUND.
C
 201  CALL NRAN31(R1,R2)
C
C    UPDATE TIME BY FLIGHT TIME OF MAIN ROUND.
C
      T=T+FLT
C
C    UPDATE CENTER OF IMPACT FOR MAIN ROUNDS.
C
      XC1=R1*SIGXB+XC+XB+XC1
      YC1=R2*SIGYB+YC+YB+YC1
C
C    FAC IS A FACTOR TO INCLUDE LAY ERROR IF IT IS 1.
C
      FAC=1.
```

are used to set the lay error flag and to update the time-to-kill and center of impact for the first main round of each sample after calling Subroutine NRAN31 in order to provide the random normal deviates required to compute the horizontal and vertical aim coordinates of the first main round in accordance with the following equations.

First main round:

$$XC1 = (R1)(\sigma_{XB}) + XC + XB \qquad (2\text{-}1)$$

MAIN ROUTINE (5 of 13)

$$YC1 = (R2)(\sigma_{YB}) + YC + YB \qquad (2\text{-}2)$$

First main round subsequent to spotting rifle round:

$$XC1 = (R9)(\sigma_{XB}) + XC + XB + XC3 \qquad (2\text{-}7)$$

$$YC1 = (R10)(\sigma_{YB}) + YC + YB + YC3 \qquad (2\text{-}8)$$

The statements

```
C
C    ENTER MAIN ROUND LOOP.
C
      J=0
 985  J=J+1
C
C    IH10 IS A SWITCH TO TELL IF THIS IS MAIN ROUND OR NOT. IH10=1 IS MAIN
C    ROUND.
C
      IH10=1
      IH20=0
C
C    SAMPLE IMPACT POINT FOR THIS ROUND
C
      IF(FAC.EQ.0.)GOTO101
C
C    IF ROUND HAS BEEN SENSED BEFORE, EXCLUDE THE LAY ERROR.
C
      CALL NRAN31(R1,R2)
      X2=SIGXL*R1
      Y2=SIGYL*R2
```

are used to initialize the main rounds fired counter, to execute the main round loop, to set the main round flag, and to test the lay error flag. If a main round has not been sensed previously, Subroutine NRAN31 is called to supply the random normal deviates required to quantify the lay error in the horizontal and vertical directions.

The statements

```
 101  CALL NRAN31(R1,R2)
C
C    FIND IMPACT POINT OF THIS MAIN ROUND.
```

MAIN ROUTINE (6 of 13)

```
C
      X1=XC1+R1*SIGXR+FAC*X2
      Y1=YC1+R2*SIGYR+FAC*Y2
C
C   UPDATE THE TIME FOR THIS MAIN ROUND.
C
      CALL NRAN31(T1,T2)
      IF(J.EQ.1)GOTO159
      HWM=XM2*EXP(T1*ST2)
      IF(HWM.LE.AMT2) HWM=AMT2
      T=T+HWM+TFS
      GOTO160
  159 HWM=XM1*EXP(T1*ST1)
      IF(HWM.LE.AMT1) HWM=AMT1
      T=T+HWM+TF1
```

are used to update the time-to-kill the target and to compute the main round impact point after calling Subroutine NRAN31 which provides the random normal deviates necessary for these computations in accordance with the equations:

$$X1 = XC1 + (R3)(\sigma_{XR}) + (\sigma_{XL})(R4) \qquad (2\text{-}3)$$

$$Y1 = YC1 + (R5)(\sigma_{YR}) + (\sigma_{YL})(R6) \qquad (2\text{-}4)$$

$$HWM = (XM)\ \exp[(R9)(ST)] \qquad (2\text{-}10)$$

$$T_I = T_C + HWM + TFS \qquad (2\text{-}11)$$

If the target is defiladed on any main or spotting round, or if the impact point of any main or spotting round lies outside of the enveloping target grid cells, or if the identifying kill array has no target kill criteria associated with the cell which is identified as hit, control is transferred to Statement 1 by execution of the statements

```
C
C   IS TARGET DEFILADED?
C
  160 IF(Y1.LT.YDEF) GO TO 1
```

MAIN ROUTINE (7 of 13)

```
C
C    IS THIS ROUND WITHIN VULNERABILITY MATRIX?
C
      IF(X1.LT.AX(1   ))GOTO1
      IF(X1.GT.AX(NX+1))GOTO1
      IF(Y1.LT.AY(1   ))GOTO1
      IF(Y1.GT.AY(NY+1))GOTO1
C
C    WHERE IS THIS ROUND IN THE VULNERABILITY MATRIX?
C
      J1=1
 3    J1=J1+1
      IF(Y1.GT.AY(J1))GOTO3
      J1=J1-1
 31   J2=1
 4    J2=J2+1
      IF(X1.GT.AX(J2))GOTO4
      J2=J2-1
C
C    IS THIS ROUND A HIT?
C
      IF(IK(J1,J2).LE.0 )GOTO1
```

Then the statements

```
C
C    IF THIS IS A SPOTTING RIFLE HIT UPDATE NUMBER OF ROUNDS IT TOOK AND
C    START FIRING THE MAIN ROUND.
C
      IF(TH10.EQ.0) TH13=TH13+TH11
      IF(TH10.EQ.0)GOTO204
```

are used to update the total number of spotting rounds fired to achieve a spotting rifle round target hit before transferring control to Statement 204 to fire a main round. Diminution of weapon effectiveness attributed to the reliability of the round is achieved by the execution of the statement

```
C
C    IS THIS HIT A RELIABLE ROUND?
C
      IF(RANDOM( 1).GT.REL)GOTO97
```

The statements

```
C
C    IF THIS HIT IS NOT THE FIRST HIT GO TO 55
C
      IF(THW.GT.0)GOTO55
C
C    UPDATE THE PROBABILITY ARRAY AND TIME ARRAY FOR THIS HIT.
C
      THW=1
      J10=J
      DO51K=J10,NRDS
 51   Z(K,6)=Z(K,6)+1.
      J10=2.+T/2.
```

MAIN ROUTINE (8 of 13)

```
      IF(J10.GT.61)GOTO55
      DO151J11=J10,61
  151 AKTL(J11,6)=AKTL(J11,6)+1.
```

are used to update the cumulative results of the target and time arrays by identifying the first main round hit and time for each sample case.

The statements

```
C
C   DOES THIS HIT HAVE A RELIABLE FUZE?
C
   55 IF(RANDOM(1).GT.RELF)GOTO97
      IH20=1
```

are used to check fuze actuation and to set the fuze actuation flag.

The statements

```
C
C   IS THIS HIT A KILL?
C
      HW2=RANDOM(1)
      K22=IK(J1,J2)
      HW1=0.
C
C   4 DIFFERENT KILL CRITERIA ARE CONSIDERED.
C
      DO93K21=1,4
      IF(C(K21).GT.0.)GOTO93
      IF(PK(K22,K21).LT.HW2)GOTO92
C
C   IF THIS HIT IS A KILL FOR THIS CRITERION UPDATE PROBABILITY ARRAY AND
C    TIME ARRAY.
C
      J10=2.+T/2.
      IF(J10.GT.61)GOTO152
      DO153J11=J10,61
  153 AKTL(J11,K21)=AKTL(J11,K21)+1.
  152 DO42K20=1,NRDS
   42 Z(K20,K21)=Z(K20,K21)+1.
      C(K21)=1.
      GOTO93
   92 HW1=1.
   93 CONTINUE
```

are used to set the number of kill criteria and to execute the kill criteria loop. If the kill flag array element designating a given kill criterion is greater than zero, (indicating achievement of target kill for that criterion by a previous round) the loop is re-entered for execution. If the Pk value for the designated kill criterion of the impacted target grid cell is less than a selected uniform random number between zero and one, the flag indicating failure to achieve all kill criteria is set. If the target hit achieves a kill for the criterion under consideration, the probability of target kill array and the time-to-kill array (providing that the time-to-kill does not exceed 120 seconds) are updated to ultimately reflect the cumulative results of all 9,604 sample cases.

MAIN ROUTINE (9 of 13)

The statements

```
C
C    IF THIS ROUND WAS NOT A KILL FOR ALL CRITERIA GO FIRE ANOTHER ROUND.
C
      IF(HW1.GT.0.)GOTO97
      IF(PASSN.GT.0.)GOTO97
C
C    IF THIS ROUND IS A KILL FOR ALL CRITERIA GO TO NEXT SAMPLE.
C
      GOTO99
```

are used to transfer control to fire another round or to proceed to run the next sample case after examining the kill criteria and target passenger flags.

The statements

```
C
C    IF THIS IS THE MAIN ROUND GO TO 203
C
 1    IF(IH10.NE.0)GOTO203
C
C    IF THE SPOTTING RIFLE HAS SHOT MORE OR EQUAL TO THE SPECIFIED ROUNDS.
C
      IF(IH11.GE.NRDS1)GOTO206
C
C    WAS THIS ROUND SENSED?
C
      IF(RANDOM(1).GT.PR  S1)GOTO200
C
C    CORRECT CI IN PARALLELOGRAM FASHION.
C
      CALL NRAN31(R1,R2)
      XC1=XC1-X1+XC-R1*SIGXS1
      YC1=YC1-Y1+YC-R2*SIGYS1
      FAC=0.
C
C    FIRE ANOTHER SPOTTING ROUND.
C
      GOTO200
```

are used to identify the round fired. If the round was a main round, control is passed to Statement 203. If the round was a spotting rifle round, a test for the maximum number of spotting rounds fired is made; then a uniform random number is chosen to determine if the miss of the spotting rifle round was sensed. If the miss of the spotting rifle round was sensed, Subroutine NRAN31 is called to furnish the random normal deviates required to update the horizontal and vertical coordinates of the center of impact of the spotting rounds. Control is then transferred to Statement 200 to fire another spotting round.

MAIN ROUTINE (10 of 13)

The statements

```
C
C   CORRECT THE CENTER OF TARGET OUT OF CENTER OF IMPACT BECAUSE IT WILL
C   BE ADDED IN WHEN MAIN ROUND IS FIRED.
C
 204  XC1=XC1-XC
      YC1=YC1-YC
      GOTO201
```

are used to modify the horizontal and vertical coordinates of the center of impact for the spotting rounds before control is transferred to Statement 201 to fire a main round.

The statements

```
 206  TH12=TH12+1
      TH13=TH13+TH11
C
C   IF ALL OF SPOTTING RIFLE ROUNDS HAVE BEEN FIRED AND ROUND IS NOT WITH
C   IN 12 INCHES OF TARGET GO TO NEXT SAMPLE OTHERWISE FIRE MAIN ROUND.
C
      IF(AX(1 )-12..GT.X1) GOTO99
      IF(AX(NX)+12..LT.X1) GOTO99
      IF(AY(NY)+12..LT.Y1) GOTO99
      IF(AY(1 )-12..GT.Y1) GOTO99
      GOTO204
```

are used to update the spotting round counters and to determine whether to proceed to run the next sample case or to fire a main round if the spotting round impact point lies within 12 inches of the enveloping target grid cell area.

The statements

```
C
C   IF THE MISS OF THE MAIN ROUND IS NOT SENSED FIRE ANOTHER ROUND WITH
C   NO CORRECTION.
C
 203  IF(RANDOM(1).GT.PROBS) GO TO 97
C
C   CORRECT CT FOR NEXT ROUND USING PARALLELOGRAM METHOD.
C
      CALL NRAN31(R1,R2)
      XC1=XC1-X1+XC-R1*SIGXS
      YC1=YC1-Y1+YC-R2*SIGYS
      FAC=0.
 97   CONTINUE
```

are used to update the horizontal and vertical coordinates of the center of impact for the main rounds after calling Subroutine NRAN31 to provide the required random normal computational deviates (in accordance with the equations which follow) if the miss of the main round was sensed.

MAIN ROUTINE (11 of 13)

$$XC2 = XC1 - X1 + XC - (R7)(\sigma_{XS}) \qquad (2\text{-}5)$$

$$YC2 = YC1 - Y1 + YC - (R8)(\sigma_{YS}) \qquad (2\text{-}6)$$

The statements

```
      IF(PASSN.LE.0.)GOTO98
C
C   CHECK FUZE ACTUATION.
C
      IF(IH20.EQ.0)GOTO302
C
C   PERSONNEL CASUALTIES COMPUTED.
C
      SUMCAS =SUMCAS +(PK(K22,5)/PASSN)*(PASSN-SUMCAS )
  302 Z(J,5)=Z(J,5)+SUMCAS
   98 CONTINUE
C
C   FIRE NEXT MAIN ROUND.
C
      IF(J.LT.NRDS)GOTO985
C
C   GO TO NEXT SAMPLE.
C
   99 CONTINUE
```

are used to check the passenger flag in order to compute the number of target passengers killed for the cell hit under consideration if the fuze actuation flag is not equal to zero. The cumulative Pk array containing target passengers killed per rounds fired is then updated before either firing another main round or continuing with the execution of another Monte Carlo trial.

The statements

```
C
C   SAMPLING IS COMPLETE.
C
      WRITE(6,7)
    7 FORMAT(//12H NRDS      PK/)
C
C   COMPUTE MEAN PK AND PH TARGET DATA AND WRITE RESULTS.
C
```

MAIN ROUTINE (12 of 13)

```
      SAMP=NSAMP
      SAMPI=1./SAMP
      DO 96 I2=1,NRDS
      DO91I=1,6
   91 Z(I2,I)=Z(I2,I)*SAMPI
   87 WRITE(6,6)I2,(Z(I2,I),I=1,6)
   96 CONTINUE
```

are used to reduce the cumulative Pk target array representing 9,604 Monte Carlo samples for all kill criteria considered to mean values and to write them for output. The average number of spotting rounds fired and the number of times that all the spotting rounds were fired is also written by the execution of the statements

```
      IH13=IH13/NSAMP
C
C   IH12 IS NUMBER OF TIMES FIRED ALL SPOTTING ROUNDS, IH13 IS AVERAGE
C   NUMBER OF SPOTTING ROUNDS FIRED.
C
      WRITE(6,251) IH12,IH13
  251 FORMAT(2I5)
```

The statements

```
C
C   COMPUTE MEAN PK AND PH TIME DATA AND WRITE RESULTS.
C
      WRITE(6,61)
      DO154I=1,61
      DO154J=1,6
  154 AKTL(I,J)=AKTL(I,J)*SAMPI
      DO155J=1,6
      WRITE(6,156)(AKTL(I,J),I=1,61)
  156 FORMAT(10E8.5)
      WRITE(6,157)
  157 FORMAT(1H0)
  155 CONTINUE
```

are used to reduce the cumulative Pk time array to mean values and to write them for output in accordance with equation:

$$\bar{\ell} = \frac{\sum_{i=1}^{n} \ell i}{n} \qquad (2\text{-}12)$$

MAIN ROUTINE (13 of 13)

The statements

```
C
C    COMPUTE AVERAGE NO. OF RDS. FIRED.
C
      IF(NOPT1.EQ.3)GOTO2
      CALL KILRAT
C
C    GO TO READ NEXT DATA SET.
C
      GOTO2
 6    FORMAT(I5,  9F13.7)
 61   FORMAT(1H1)
 62   FORMAT(///21H NUMBER OF SAMPLES = ,I6,/1H1)
      END
```

are used to call Subroutine KILRAT to compute the average number of main rounds fired per case if the program option flag is not equal to three. Control of the program transfers to Statement 2 to read a new data set.

FUNCTION CNF(X)

This function is used to compute the cumulative normal distribution values needed to determine the probability of target cell impact by a main round for the closed form solution.

The statements

```
      FUNCTION CNF(X)
C*************************************************************************************
C    PURPOSE
C    COMPUTES CUMULATIVE NORMAL DISTRIBUTION VALUES FOR CELL PH USED
C    IN CLOSED FORM SOLUTION.
C*************************************************************************************
C
      F=0.
      AX=ABS(X)*.7071068
      IF(AX.GE.5.)GOTO3
      F=.5-.5*ERF(AX)
3     IF(X.GE.0.)F=1.-F
      CNF=F
      RETURN
      END
```

are used to generate values from the cumulative normal distribution utilizing the error function associated with the normal curve. Control then is returned to the calling routine.

SUBROUTINE INPUT (1 of 5)

The purpose of this subroutine is to read and write the input data, to convert the input data into units suitable for program execution, and to set up the target grid and Pk arrays. The subroutine is begun by the statements

```
      SUBROUTINE INPUT
C*************************************************************************
C    PURPOSE.
C    READ AND WRITE INPUT DATA, CONVERT UNITS OF INPUT DATA, AND SET UP
C    THE TARGET GRID AND PK ARRAYS.
C*************************************************************************
C
      DIMENSION PK(3000 ,8),AX(201),AY(51 ),CASE(40),Z(19,9),Z1(61)
      COMMON PK,AX,AY,SXR,SYR,SXB,SYB,SXS,SYS,PRS,XB,YB,XC,YC,RFL,TF1,
     1TFS,XM1,XM2,YDEF,NOPT1,NRDS,NX,NY,FLT,ST1,ST2,AMT1,AMT2,IK(50,200)
     2,Z,Z1,AKIL(61,9),SIGXL,SIGYL,RELF
     3,S  XS1,S  YS1,S  XB1,S  YB1,S  XR1,S  YR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
```

which are used to allocate storage for arrays and to provide exchange of data between this subroutine and the remainder of the program.

The statements

```
C
C  READ AND WRITE TITLE CARD.
C
      READ(5,20,END=6) CASE
 20   FORMAT(40A2)
      WRITE(6,18) CASE
 18   FORMAT(1H1,40A2)
C
C    READ MAIN ROUND DATA.
C
      READ(5,1,END=6)NOPT1,NRDS,NOPT,XC,YC,SXS,SYS,SXB,SYB,SXR,SYR,PRS,R
     1FL,YDEF,XB,YB,FLT,TF1,TFS,XM1,XM2,AMT1,AMT2,ST1,ST2,SIGXL,SIGYL,
     2RELF,PASSN
C
C    CHECK FLAG TO READ SPOTTING ROUND DATA.
C
      IF(NOPT1.NE.2)GOTO201
      READ(5,204)NRDS1,SXS1,SYS1,SXB1,SYB1,SXR1,SYR1,PRS1,XB1,YB1,FLT1,
     1TF11,TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1
 204  FORMAT(I5,5X,7F10.2,/8F10.2,/8F10.2)
C
C    NUMBER OF MAIN ROUNDS FIRED PER SAMPLE SPECIFIED.
C
 201  IF(NRDS.LT.10) NRDS=10
      IF(NRDS.GT.19) NRDS=19
      IF(NOPT1.EQ.3) NRDS=1
C
C    WRITE MAIN ROUND INPUT DATA.
C
      WRITE(6,2)NOPT1,NRDS,NOPT
 2    FORMAT(    ////////////21H          SIMULATION = ,I5,/20H NUMBER OF R
     1OUNDS = ,I5,/8H NOPT = ,I5)
      WRITE(6,3)
```

```
  3     FORMAT(//28X,24H HORIZONTAL    VERTICAL  ,//31X,7H METERS, 5X,7H ME
       1TERS,/)
        WRITE(6,4)SXS,SYS,SXB,SYB,SXR,SYR,XB,YB,XC,YC,SIGXL,SIGYL
  4     FORMAT(26H SENSING ERRORS (STD DEV) ,2F12.4,/24H VARIABLE BIAS (ST
       1D DEV),2X,2F12.4,/24H RANDOM ERRORS (STD DEV),2X,2F12.4,/11H FIXED
       2 BIAS,15X,2F12.4,/11H AIM CENTER,15X,2F12.4/,10H LAY ERROR,16X,
       32F12.4/)
        WRITE(6,7)PRS,REL,YDEF,RELF
  7     FORMAT(39H PROBABILITY OF SENSING MISSING ROUND =,F12.6,/23H RELIA
       1BILITY OF ROUND = ,F12.6,/34H VERTICAL DEFILADED COORDINATES = ,
       2F12.6,7H INCHES/,23H RELIABILITY OF FUZE = ,F28.6)
        WRITE(6,19)FLT,TF1,TFS,XM1,XM2,AMT1,AMT2,ST1,ST2
 19     FORMAT(/////32X,16H TIME DATA(SECS),///18H TIME OF FLIGHT = ,F12.6
       1,///26X,10H 1ST ROUND,9X,16H SUBSEQUENT RDS.,//25H FIXED MEDIAN TI
       2ME       ,F12.6,10X,F12.6,/25H VARIABLE MEDIAN TIME    ,F12.6,10X,
       3F12.6,/25H MINIMUM TIME             ,F12.6,10X,F12.6,/25H SLOPE OF
       4DISTRIBUTION   ,F12.6,10X,F12.6)
```

are used to set the number of main rounds to be fired per sample and to read and write the input data for the main rounds and, if the program option flag so governs, for the spotting rifle round data.

The statements

```
C
C    CONVERT MAIN RD. DELIVERY DATA FROM METRIC TO ENGLISH STANDARD UNITS.
C
       SXS=SXS*39.37
       SYS=SYS*39.37
       SXB=SXB*39.37
       SYB=SYB*39.37
       SXR=SXR*39.37
       SYR=SYR*39.37
       SIGXL=SIGXL*39.37
       SIGYL=SIGYL*39.37
       XB =XB *39.37
       YB =YB *39.37
       XC=XC*39.37
       YC=YC*39.37
C
C    CHECK FLAG FOR WRITING SPOTTING RIFLE ROUND DATA.
C
       IF(NOPT1.NE.2)GOTO202
       RELF1=1.
       REL1=1.
       WRITE(6,18)
       WRITE(6,203)
 203   FORMAT(///20H SPOTTING RIFLE DATA,//)
       WRITE(6,3)
       WRITE(6,4)SXS1,SYS1,SXB1,SYB1,SXR1,SYR1,XB1,YB1,XC,YC,SIGXL1,SIGYL
      11
       WRITE(6,7)PRS1,REL1,YDEF,RELF1
       WRITE(6,19)FLT1,TF11,TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21
C
C    CONVERT SPOT RD. DELIVERY DATA FROM METRIC TO ENGLISH STANDARD UNITS.
C
       SXS1=SXS1*39.37
       SYS1=SYS1*39.37
       SXB1=SXB1*39.37
       SYB1=SYB1*39.37
```

```
      SXR1=SXR1*39.37
      SYR1=SYR1*39.37
      STGXL1=STGXL1 *39.37
      STGYL1=STGYL1 *39.37
      XB1=XB1*39.37
      YB1=YB1*39.37
```

are used to convert the input data from metric units to English standard measure units. The spotting rifle round data is written if the option flag is equal to two.

The statements

```
C
C   CREW PROFICIENCY TIME FACTORS SET.
C
      IF(ST11.EQ.0.) ST11=.4983
      IF(ST21.EQ.0.) ST21=.4983
 202  IF(ST1.EQ.0.) ST1=.4983
      IF(ST2.EQ.0.) ST2=.4983
C
C   CHECK INPUT CONTROL FLAG FOR USING PREVIOUS DATA SET UP.
C
      IF(NOPT.EQ.0)RETURN
```

are used to set the slope of the variable time distribution for the crew proficiency exponential equation and to return control to the calling routine if the flag NOPT is equal to zero indicating that the vulnerability matrix, the identifying kill array, and the Pk array remain as in the previous input data set.

Descriptive target data such as the number and size of target grid cells in the horizontal and vertical directions and the minimum horizontal and minimum vertical coordinate values which can be assumed by the grid area enveloping the target are read by the execution of the statements

```
C
C   READ TARGET DATA.
C
      READ(5,1)NX,NY
      NX1=NX+1
      NY1=NY+1
  1   FORMAT(3I5,5X,6F10.2,/8F10.2,/8F10.2,/8F10.2)
 15   READ(5,51)XMIN,YMIN,DX,DY
```

The statements

```
C
C   SET VULNERABILITY CARD LIMIT.
C
      NC=3000
C
C   SET UP VULNERABILITY MATRIX.
C
      AX(1)=XMIN
      DO 16 I=2,NX1
```

SUBROUTINE INPUT (4 of 5)

```
 16    AX(I)=AX(I-1)+DX
       AY(1)=YMIN
       DO 17 I=2,NY1
 17    AY(I)=AY(I-1)+DY
C
C    INITIALIZE ID KILL ARRAY.
C
 56    DO54I=1,NX
       DO54J=1,NY
 54    IK(J,I)=0
```

are used to limit the number of Pk input cards to 3,000, to initialize the identifying kill array, and to set up the arrays containing the incremented horizontal and vertical values of the grid area enveloping the target.

The statements

```
C
C    ENTER VULNERABILITY CARD LOOP.
C
       DO52I=1,NC
       NC1=5
       IF(PASSN.LE.0.)NC1=4
C
C    CHECK FLAG FOR STANDARD ARRAY SET UP.
C
       IF(NOPT.EQ.1)GOTO303
C
C    REVERSE TARGET ORIENTATION.
C
       READ(5,304)X,Y,(PK(I,J),J=1,NC1)
       X=-X
       GOTO302
 303   READ(5,305)X,Y,(PK(I,J),J=1,NC1)
 304   FORMAT(2F7.2,38X,4F7.1)
 305   FORMAT(2F7.2, 6X,5F7.1)
C
C    CHECK FOR LAST VULNERABILITY CARD.
C
 302   IF(X.GT.999.) RETURN
C
C    CONVERT TARGET COORDINATES INTO ID KILL ARRAY SUBSCRIPTS.
C
       J1=((X-XMIN)/DX)+1.
       J2=((Y-YMIN)/DY)+1.
 52    IK(J2,J1)=I
 10    FORMAT(1H1)
       RETURN
 51    FORMAT(4F10.1,I5)
 6     CALL EXIT
       END
```

are used to read the Pk vulnerability data for the various selected kill criteria for a given point on the target. If the personnel casualty flag is less than or equal to zero, only four target kill criteria are considered. Otherwise, personnel casualty data are also read. If the

input control flag is equal to one, the Pk and identifying kill arrays are set up in standard fashion so that the given target coordinates are converted into the identifying kill array subscripts which correspond with the subscripts of the target-enveloping grid area arrays. If the input control flag is greater than one, the orientation of the target is reversed, and the appropriate Pk vulnerability data are read accordingly. Control is then returned to the calling routine.

SUBROUTINE KILRAT (1 of 2)

This subroutine is used to compute and write the average number of main rounds fired for each case.

The statements

```
      SUBROUTINE KILRAT
C
C*****************************************************************************
C    PURPOSE
C    COMPUTES AND WRITES THE AVERAGE NUMBER OF MAIN ROUNDS FIRED PER CASE.
C*****************************************************************************
C
      DIMENSION AKIL( 61,9),F( 61),G( 61),SMK(19 ,9),AA( 61),PK(3000,8),
     1AX(201),AY(51)
      COMMON PK,AX,AY,SIGXR,SIGYR,SIGXB, SIGYB,SIGXS,SIGYS,SIG   ,XB,YB,
     1XC,YC,REL,TF1,TFS,XM1,XM2,YDEF,NOPT1,NR   ,NX,NY,FLT,ST1,ST2,AMT1,
     2AMT2,TK(50,200),SMK,F,AKIL,SIGXL,SIGYL,RELF
     3,SIGXS1,SIGYS1,SIGXB1,SIGYB1,SIGXR1,SIGYR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
```

are used to allocate storage for arrays and to provide for the exchange of data between this subroutine and the remainder of the program.

The statements

```
C
C    ENTER CASE LOOP.
C
      DO 2 I1=1,6
      SMIK=SMK(1,I1)
      AUL=2.
      ANR=NR
      J=NR
C
C    ENTER ROUND LOOP AND COMPUTE AVG. RDS. FIRED.
C
      DO25I=2,J
      SMIK=SMIK+(AUL*(SMK(I,I1)-SMK(I-1,I1)))
 25   AUL=AUL+1.
C
C    DID ALL SAMPLES REGISTER A KILL?
C
      IF(SMK(NR,I1).GT..9999) GOTO99
```

are used to enter the case loop and to execute the round loop to compute the average number of main rounds fired for a given case or kill criterion in accordance with the equation:

$$AV1 = \sum_{i=1}^{r} i(P_i - P_{i-1}) \qquad (2\text{-}13)$$

SUBROUTINE KILRAT (2 of 2)

If a kill occurs within the set number of rounds fired for each sample of a case, control transfers to Statement 99 to write out the results.

The statements

```
      AR=5.-(SMK(J-5,I1)+SMK(J-4,I1)+SMK(J-3,I1)+SMK(J-2,I1)+SMK(J-1,I1))
     1)
      XX=SMK(J  ,I1)-SMK(J-5,I1)
      IF(XX.LE.0.)GOTO99
      AZ=AR/XX
C
C   COMPUTE AVG RDS FIRED INCLUDING NON-KILLING SAMPLES AND EXTRAPOLATION FACTOR
C
      AV=(AZ+ANR)*(1.-SMK(J  ,I1))+SMIK
      GOTO98
C
C   WRITE AVG ROUNDS FIRED PER CASE.
C
 99   AV=SMIK
 98   WRITE(6,26) AV,I1
 26   FORMAT(16H AVG. NO. RDS = ,F7.2,8H CASE = ,I5,//)
    2 CONTINUE
      RETURN
      END
```

are used to compute the average number of rounds fired per case including those rounds fired on non-killing samples and an error estimate based upon extrapolation to the limit in accordance with the equation:

$$AV2 = r(1 - P_r) + \left(\frac{1 - P_r}{P_r - P_{r-5}}\right)\left(5 - \sum_{i=r-5}^{r-1} P_i\right) + AV1 \qquad (2\text{-}14)$$

After all results are computed and written, control is returned to the calling routine.

SUBROUTINE NRAN31 (X1, X2)

The purpose of this subroutine is to generate random numbers representing normal deviates for use in establishing aimpoints, impact points, and time-to-kill values for both main and spotting rounds.

The statements

```
      SUBROUTINE NRAN31(X1,X2)
C
C*****************************************************************************
C    PURPOSE
C    GENERATES RANDOM NORMAL DEVIATES.
C
C    FUNCTION RANDOM REQUIRED.
C*****************************************************************************
C
      X3=SQRT(-2.*ALOG(RANDOM(1)))
      X4=6.283185307*RANDOM(1)
      X2=X3*SIN(X4)
      X1=X3*COS(X4)
      RETURN
      END
```

are used to produce two normal deviates which are employed to establish aimpoints, impact points, and time-to-kill values after calling Function RANDOM and applying the sine and cosine functions as factors. Control is then returned to the calling routine.

FUNCTION RANDOM (N)

This function is used to generate uniform random numbers in the interval between zero and one. The subroutine is begun by the statements

```
      FUNCTION RANDOM(N)
C*****************************************************************************
C    PURPOSE
C    GENERATES UNIFORM RANDOM NUMBERS BETWEEN 0. AND 1.
C*****************************************************************************
C
      COMMON/ RANDM/IX
```

which provide for the exchange of data between this function and the remainder of the program.

The statements

```
      IX=IX*65539
      IF(IX)5,6,6
5     IX=IX+2147483647+1
6     SUM =IX
1     SUM=SUM*.4656613E-9
      RANDOM=SUM
      RETURN
      END
```

generate a random number by first multiplying two large integers. If overflow is produced, the random number is made positive by adding 2^{31}. The resulting random number produced after subsequently multiplying by the constant 2^{-31}, lies in the interval between zero and one. Control is then returned to the calling routine.

SUBROUTINE SSHOT (PCH, PCH1) (1 of 3)

The purpose of this subroutine is to compute the probability of hitting the target for a single main round and the probability of hitting the target for a single main round given a sensed miss by using a closed form solution.

The subroutine is begun by the statements

```
      SUBROUTINE SSHOT(PCH,PCH1)
C
C*****************************************************************************
C    PURPOSE
C    COMPUTES PH TARGET FOR A SINGLE MAIN ROUND AND FOR A SINGLE MAIN ROUND
C    GIVEN A SENSED MISS BY USING A CLOSED FORM SOLUTION.
C
C    FUNCTION ONE REQUIRED.
C*****************************************************************************
C
      DIMENSION PK(3000 ,8),AX(201),AY(51 ),Z(19,9),Z1(61)
      COMMON PK,AX,AY,SIGXR,SIGYR,SIGXB, SIGYB,SIGXS,SIGYS,PROBS,XB,YB,
     1XC,YC,REL,TF1,TFS,XM1,XM2,YDEF,NOPT1,NRDS,NX,NY,FLT,ST1,ST2,AMT1,
     2AMT2,TK(50 ,200),Z,Z1,AKTI(61,9),SIGXL,SIGYL,RELF
     3,SIGXS1,SIGYS1,SIGXB1,SIGYB1,SIGXR1,SIGYR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
```

which are used to allocate storage for arrays and to provide for the exchange of data between this subroutine and the remainder of the program.

The standard deviations of impact error in the horizontal and vertical directions are computed in accordance with the equations:

$$\sigma_X = \sqrt{\sigma_{XR}^2 + \sigma_{XB}^2 + \sigma_{XL}^2} \qquad (2\text{-}17)$$

$$\sigma_Y = \sqrt{\sigma_{YR}^2 + \sigma_{YB}^2 + \sigma_{YL}^2} \qquad (2\text{-}18)$$

$$\sigma_A = \sqrt{\sigma_{XS}^2 + 2(\sigma_{XR})^2} \qquad (2\text{-}19)$$

SUBROUTINE SSHOT (2 of 3)

$$\sigma_B = \sqrt{\sigma_{YS}^2 + 2(\sigma_{YR})^2} \qquad (2\text{-}20)$$

These standard deviations of impact error utilize the system and random input delivery error data for a main round and for a main round given a sensed miss by execution of the following statements

```
      PCH =0.
      PCH1=0.
C
C     COMPUTE IMPACT SIGMAS FOR A SINGLE MAIN ROUND.
C
      SIGX=SQRT(SIGXR**2+SIGXB**2+SIGXL**2)
      SIGY=SQRT(SIGYR**2+SIGYB**2+SIGYL**2)
      SIGA=SQRT(SIGXS**2+2.*SIGXR**2)
      SIGB=SQRT(SIGYS**2+2.*SIGYR**2)
```

The statements

```
C
C     CHECK FOR SPOTTING ROUND DATA.
C
      IF(NOPT1.NE.2)GOTO3
C
C     MODIFY IMPACT SIGMAS.
C
      SIGX=SQRT(SIGX**2+(.5*(SIGXS1+SIGXL1))**2+SIGXR1**2)
      SIGY=SQRT(SIGY**2+(.5*(SIGYS1+SIGYL1))**2+SIGYR1**2)
```

are used to modify the standard deviations of the main round computed above by incorporating spotting rifle round delivery error data if the option flag, NOPT1, is equal to two in accordance with the equations:

$$\sigma_{X1} = \sqrt{\sigma_X^2 + [.5(\sigma_{XS1} + \sigma_{XL1})]^2 + \sigma_{XR1}^2} \qquad (2\text{-}21)$$

$$\sigma_{Y1} = \sqrt{\sigma_Y^2 + [.5(\sigma_{YS1} + \sigma_{YL1})]^2 + \sigma_{YR1}^2} \qquad (2\text{-}22)$$

SUBROUTINE SSHOT (3 of 3)

The statements

```
C
C    ENTER LOOP TO  SELECT CELL VERTICAL COORDINATES.
C
 3     DO2J=1,NY
       Y2=AY(J+1)-YC
       Y1=AY(J  )-YC
C
C    CHECK TARGET DEFILADED CONDITIONS.
C
       IF(AY(J+1).LE.YDEF) GOTO2
       IF(AY(J  ).LT.YDEF) Y1=YDEF-YC
C
C    ENTER LOOP TO SELECT CELL HORIZONTAL COORDINATES.
C
       DO1I=1,NX
C
C    CHECK THAT CELL IN TARGET.
C
       IF(IK(J,I).LE.0 )GOTO1
       X1=AX(I  )-XC
       X2=AX(I+1)-XC
C
C    COMPUTE AND SUM CELL PH'S.
C
       PA =(CNF((X2-XB)/SIGX)-CNF((X1-XB)/SIGX))*(CNF((Y2-YB)/SIGY)-CNF((
      1Y1-YB)/SIGY))
       PA1=(CNF(X2/SIGA)-CNF(X1/SIGA))*(CNF(Y2/SIGB)-CNF(Y1/SIGB))
       PCH =PCH +PA
       PCH1=PCH1+PA1
 1     CONTINUE
 2     CONTINUE
       RETURN
       END
```

are used to execute the target cell loops in order to set up the vertical and horizontal coordinates of each target cell to be examined. If the target cell is defiladed, the vertical cell loop is re-entered. If the target cell has no associated Pk values, the horizontal cell loop is re-entered. The probabilities of hitting each cell for a single main round and the probabilities of hitting each cell for a single main round given a sensed miss are computed by using the cumulative normal distribution function, then appropriately summed in accordance with Equations 2-15 and 2-16 before control returns to the calling routine.

$$PA_i = \frac{1}{2\pi\sigma_X\sigma_Y} \int_{A_i}\int \exp - \left(\frac{X^2}{2(\sigma_X)^2} + \frac{Y^2}{2(\sigma_Y)^2}\right) dX\ dY \qquad (2\text{-}15)$$

$$Ph = \sum_{i=1}^{a} PA_i \qquad (2\text{-}16)$$

ABBREVIATIONS AND SYMBOLS

The following pages are a dictionary providing definitions for the various abbreviations and symbols employed in the Simulation Model. The list is ordered as follows. Those symbols appearing in blank COMMON appear first, in alphabetical order. These are followed by those symbols appearing in labeled COMMON. The labeled COMMON groups are ordered alphabetically by COMMON label name and those symbols within each COMMON block are ordered alphabetically. Finally, those symbols which appear only in a single routine are grouped according to the routine in which they appear. The MAIN Routine appears first with the subroutine groups ordered alphabetically according to subroutine name. The symbols within each subroutine group are ordered alphabetically.

Along with the symbol definition, the equivalent symbol in the Mathematical Model is provided for cross referencing. The parameter units are provided as well. A dash (---) in the units column indicates that the parameter is nondimensional.

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (1 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
AKIL(61,9)	---	Array containing mean time Pk values and mean time Ph values (cumulative values until reduced to mean values).	---
AMT1	---	Minimum time for first main round.	seconds
AMT2	---	Minimum time for main rounds subsequent to the first round.	seconds
AMT11	---	Minimum time for first spotting round.	seconds
AMT21	---	Minimum time for spotting rounds subsequent to the first round.	seconds
AX(201)	---	Array containing the incremented X values of the grid area enveloping the target.	inches
AY(51)	---	Array containing the incremented Y values of the grid area enveloping the target.	inches
FLT	---	Projectile time of flight of main round.	seconds
FLT1	---	Projectile time of flight of spotting round.	seconds
IK(50,200)	---	Identifying kill array with subscripts matching AX and AY arrays containing sequence numbers associating Pk values with target cells.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (2 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
NOPT1	---	Flag governing program options: =1: main rounds only; =2: spotting rifle data included; =3: number of rounds fired per sample is one.	---
NR	---	Number of main rounds to be fired per sample.	---
NRDS	---	Number of main rounds to be fired per sample.	---
NRDS1	---	Number of spotting rifle rounds to be fired per sample.	---
NX	---	Number of target cells in horizontal (X) direction.	---
NY	---	Number of target cells in vertical (Y) direction.	---
PASSN	---	Number of target passengers.	---
PK(3000,8)	---	Array containing probability of target kill input values for designated x- and y-coordinates.	---
PROBS	---	Probability of sensing miss of main round.	---
PRS	---	Probability of sensing miss of main round.	---
PRS1	---	Probability of sensing miss of spotting round.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (3 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
REL	---	Reliability of main round.	---
RELF	---	Reliability of fuze of main round.	---
SIGXB	σ_{XB}	Standard deviation of horizontal variable bias for main rounds.	inches
SIGXB1	---	Standard deviation of horizontal variable bias for spotting rounds.	inches
SIGXL	σ_{XL}	Standard deviation of horizontal lay error for main rounds.	inches
SIGXL1	σ_{XL1}	Standard deviation of horizontal lay error for spotting rounds.	inches
SIGXR	σ_{XR}	Standard deviation of horizontal random error for main rounds.	inches
SIGXR1	σ_{XR1}	Standard deviation of horizontal random error for spotting rounds.	inches
SIGXS	σ_{XS}	Standard deviation of horizontal sensing error for main rounds.	inches
SIGXS1	σ_{XS1}	Standard deviation of horizontal sensing error for spotting rounds.	inches
SIGYB	σ_{YB}	Standard deviation of vertical variable bias for main rounds.	inches

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (4 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
SIGYB1	---	Standard deviation of vertical bias for spotting rounds.	inches
SIGYL	σ_{YL}	Standard deviation of vertical lay error for main rounds.	inches
SIGYL1	σ_{YL1}	Standard deviation of vertical lay error for spotting rounds.	inches
SIGYR	σ_{YR}	Standard deviation of vertical random error for main rounds.	inches
SIGYR1	σ_{YR1}	Standard deviation of vertical random error for spotting rounds.	inches
SIGYS	σ_{YS}	Standard deviation of vertical sensing error for main rounds.	inches
SIGYS1	σ_{YS1}	Standard deviation of vertical sensing error for spotting rounds.	inches
SMK(19,9)	---	Array containing mean Pk values for selected kill criteria and mean Ph of target for rounds fired.	---
ST1	ST	Slope of time distribution for first main round.	---
ST2	ST	Slope of time distribution for main rounds subsequent to the first round.	---
ST11	ST	Slope of time distribution for first spotting round.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (5 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
ST21	ST	Slope of time distribution for spotting rounds subsequent to the first round.	---
SXB	σ_{XB}	Standard deviation of horizontal variable bias for main rounds.	inches
SXB1	---	Standard deviation of horizontal variable bias for spotting rounds.	inches
SXR	σ_{XR}	Standard deviation of horizontal random error for main rounds.	inches
SXR1	---	Standard deviation of horizontal random error for spotting rounds.	inches
SXS	σ_{XS}	Standard deviation of horizontal sensing error for main rounds.	inches
SXS1	---	Standard deviation of horizontal sensing error for spotting rounds.	inches
SYB	σ_{YB}	Standard deviation of vertical variable bias for main rounds.	inches
SYB1	---	Standard deviation of vertical variable bias for spotting rounds.	inches
SYR	σ_{YR}	Standard deviation of vertical random error for main rounds.	inches
SYR1	---	Standard deviation of vertical random error for spotting rounds.	inches

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (6 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
SYS	σ_{YS}	Standard deviation of vertical sensing error for main rounds.	inches
SYS1	---	Standard deviation of vertical sensing error for spotting rounds.	inches
TFS	TFS	Fixed median time for main rounds subsequent to first round.	seconds
TFS1	TFS	Fixed median time for spotting rounds subsequent to first round.	seconds
TF1	---	Fixed median time for first main round.	seconds
TF11	---	Fixed median time for first spotting round.	seconds
XB	XB	Horizontal fixed bias for main rounds.	inches
XB1	---	Horizontal fixed bias for spotting rounds.	inches
XC	XC	Intended horizontal aim center of target.	inches
XM1	XM	Variable median time for first main round.	seconds
XM2	XM	Variable median time for main rounds subsequent to the first round.	seconds
XM11	XM	Variable median time for first spotting round.	seconds

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON (7 of 7)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
XM21	XM	Variable median time for spotting rounds subsequent to the first round.	seconds
YB	YB	Vertical fixed bias for main rounds.	inches
YB1	---	Vertical fixed bias for spotting rounds.	inches
YC	YC	Intended vertical aim center of target.	inches
YDEF	---	Vertical defiladed coordinate.	inches
Z(19,9)	---	Array containing mean Pk values for selected kill criteria and mean Ph of target values for rounds fired.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

COMMON/RANDM

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
I1, IX	---	Random seed, initially equal to 11111111.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

MAIN ROUTINE (1 of 3)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
C(4)	---	Array containing flags indicating kills for up to four established kill criteria.	---
FAC	---	Flag controlling incorporation of lay error.	---
HWM	HWM	Incremental time factor for variable crew proficiency.	seconds
HW1	---	Flag indicating achievement of all kill criteria.	---
HW2	---	Uniform random number used in determining target kills.	---
IHW	---	Flag indicating first main round hit of each sample.	---
IH10	---	Flag indicating main round being fired.	---
IH11	---	Spotting rifle round counter for each sample.	---
IH12	---	Number of times all spotting rounds fired.	---
IH13	---	Average number of spotting rounds fired.	---
IH20	---	Flag indicating fuze actuation on round hit.	---
J	---	Counter for main rounds fired per sample.	---
J10	---	Intermediate value identifying main round fired.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

MAIN ROUTINE (2 of 3)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
J10	---	Intermediate first time Pk element value in AKIL array.	seconds
K22	---	Relevant Pk values for the corresponding target cell.	---
NSAMP	---	Program sample size.	---
PCH	---	Probability of hit of single round (closed solution, Monte Carlo not used).	---
PCH1	---	Probability of hit for single round given a sensed miss (closed solution).	---
R1	---	Random normal deviate used in computing impact points of main and spotting rounds.	---
R2	---	Random normal deviate used in computing impact points of main and spotting rounds.	---
R3	---	Random normal deviate used in computing impact points of spotting rounds.	---
R4	---	Random normal deviate used in computing impact points of spotting rounds.	---
SAMP	---	Program sample size.	---
SAMPI	---	Inverse of SAMP.	---
SUMCAS	---	Number of target passengers killed.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

MAIN ROUTINE (3 of 3)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
T	T_I	Time of round impact.	seconds
T1	---	Random normal deviate used in updating time for main and spotting rounds.	---
T2	---	Random normal deviate used in updating time for main and spotting rounds.	---
XC1	XC1	Horizontal center of impact.	inches
X1	X1	Horizontal impact point of main or spotting rounds.	inches
X2	---	Horizontal coordinate of lay error contribution.	inches
YC1	YC1	Vertical center of impact for main or spotting rounds.	inches
Y1	Y1	Vertical impact point of main or spotting rounds.	inches
Y2	---	Vertical coordinate of lay error contribution.	inches

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

FUNCTION CNF

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
AX	---	Absolute value of X.	---
F	---	Represents value of cumulative normal distribution.	---
X	---	Value for which cumulative normal distribution is solved.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

SUBROUTINE INPUT (1 of 2)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
CASE	---	Title of run.	---
DX	---	Target cell size in the horizontal direction (X).	inches
DY	---	Target cell size in the vertical direction (Y).	inches
J1	---	Index of IK array matching X value for input Pk's with the index of the AX array in the horizontal direction for a given target cell.	---
J2	---	Index of IK array matching Y value for input Pk's with the index of the AY array in the vertical direction for a given target cell.	---
NC	---	Maximum number of input Pk cards which can be read (3,000).	---
NC1	---	Represents the number of Pk values per card to be read for a given x,y target coordinate.	---
NOPT	---	Input control flag. NOPT = 0: AX, AY, IK, and Pk arrays remain as in previous input data set; NOPT = 1: above arrays set up in standard fashion; NOPT $\geq$ 2: reverses standard target orientation.	---
NX1	---	Number of target cells plus one in the horizontal (X) direction.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

SUBROUTINE INPUT (2 of 2)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
NY1	---	Number of target cells plus one in the vertical (Y) direction.	---
REL1	---	Spotting round reliability.	---
RELF1	---	Spotting round fuze reliability.	---
X	---	Represents horizontal (X) target coordinate.	inches
XMIN	---	Represents minimum horizontal value of grid area enveloping target.	inches
Y	---	Represents vertical (Y) target coordinate.	inches
YMIN	---	Represents minimum vertical value of grid area enveloping target.	inches

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

SUBROUTINE KILRAT

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
ANR	r	Number of main rounds fired per sample.	---
AR	---	Intermediate variable used in computing average number of rounds fired.	---
AUL	i	Intermediate factor representing the number of rounds fired in computing SMIK.	---
AV	AV1 AV2	Average number of main rounds fired to achieve a kill for a designated case.	---
AZ	---	Intermediate variable used in computing average number of rounds fired.	---
I1	---	Case number.	---
J	r	Number of main rounds to be fired per sample.	---
SMIK	AV1	Average number of main rounds fired to achieve a kill for a designated case excluding non-killing trials.	---
XX	---	Intermediate variable used in computing average number of rounds fired.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

SUBROUTINE NRAN31

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
X1	---	Random normal deviate.	---
X2	---	Random normal deviate.	---
X3	---	Normal random number.	---
X4	---	Uniform random number, $0 < X4 < 2\pi$	radians

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

FUNCTION RANDOM

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
SUM	---	Uniform random number, $0 < SUM < 1$.	---

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

SUBROUTINE SSHOT (1 of 2)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
PA	PA_i	Probability of hitting a given grid cell of target with a single round.	---
PA1	PA_i	Probability of hitting a given grid cell of target with a single round given a sensed miss.	---
PCH	Ph	Probability of hitting target with a single round.	---
PCH1	Ph	Probability of hitting target with a single round given a sensed miss.	---
SIGA	σ_A	Horizontal standard deviation of impact error for a single main round given a sensed miss.	inches
SIGB	σ_B	Vertical standard deviation of impact error for a single main round given a sensed miss.	inches
SIGX	σ_X	Horizontal standard deviation of impact error for a single main round.	inches
SIGY	σ_Y	Vertical standard deviation of impact error for a single main round.	inches
X1	---	Represents lower horizontal (X) value of target grid cell being examined.	inches
X2	---	Represents greater horizontal (X) value of target grid cell being examined.	inches

LIST OF ABBREVIATIONS AND SYMBOLS
(SIMULATION MODEL)

SUBROUTINE SSHOT (2 of 2)

Abbreviation or Symbol	Equivalent in Mathematical Model	Definition	Units
Y1	---	Represents lower vertical (Y) value of target grid cell being examined.	inches
Y2	---	Represents upper vertical (Y) value of target grid cell being examined.	inches

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SECTION V

INPUT

The input data card set contains information concerning target description, target vulnerability, delivery accuracy, round characteristics, and crew proficiency.

The paragraphs that follow provide general information regarding input data preparation. An illustration of the input data deck organization (Figure 5-1) and descriptions of the input data card formats are provided at the end of this section.

The program option flag, NOPT1, controls execution of three possible alternatives:

- When NOPT1 = 1, only main rounds are fired for each trial of the simulation program.
- When NOPT1 = 2, main and spotting rifle rounds are fired for each trial of the simulation program.
- When NOPT1 = 3, only one main round is fired for each trial of the simulation program.

The input control flag, NOPT, also governs three options:

- When NOPT = 0, the vulnerability matrix, the identifying kill array, and the Pk array remain as constituted in the previous input data set.
- When NOPT = 1, the vulnerability matrix, the identifying kill array, and the Pk array are set up in the standard fashion to read the first group of kill data from a vulnerability card.
- When NOPT $\geq$ 2, the sign of horizontal target coordinates is reversed, thus reversing standard target orientation. This option causes a second group of kill data to be read from a vulnerability card.

The NRDS flag controls the maximum number of main rounds to be fired for each sample:

- If the input value of NRDS < 10, a maximum of 10 main rounds will be fired per sample except that the program option flag, NOPT1, prevails for one main round.
- If the input value of NRDS > 19, a maximum of 19 main rounds will be fired per sample.

Warhead input also includes round and fuze reliability data.

The target is defined by delineating its maximum and minimum grid cells in both the horizontal and vertical directions. The number of horizontal and vertical target grid cells and the size of these cells complete the input data description of the target. The number of vulnerability input cards is limited to 3,000. The last of these is denoted by a value exceeding 999. For a given point on the target, Pk cell data for each designated target kill criterion are read and stored for later processing. The program accommodates up to four target kill criteria and a fifth category concerning target passenger kills for an APC type target.

Main round and, if applicable, spotting round delivery input parameters for a stipulated range include intended aimpoint, standard deviation of horizontal and vertical sensing errors, standard deviation of horizontal and vertical variable bias, standard deviation of horizontal and vertical random errors, standard deviation of horizontal and vertical lay errors, horizontal and vertical fixed bias, and the vertical defilading coordinate if the target is defiladed. All of the above delivery input parameters are quantified in metric units except the vertical defilading coordinate which is described in English standard units. Time factor parameters for both main and spotting rifle rounds include projectile time of flight, fixed median times, variable median times, minimum times, and slope of time distribution data.

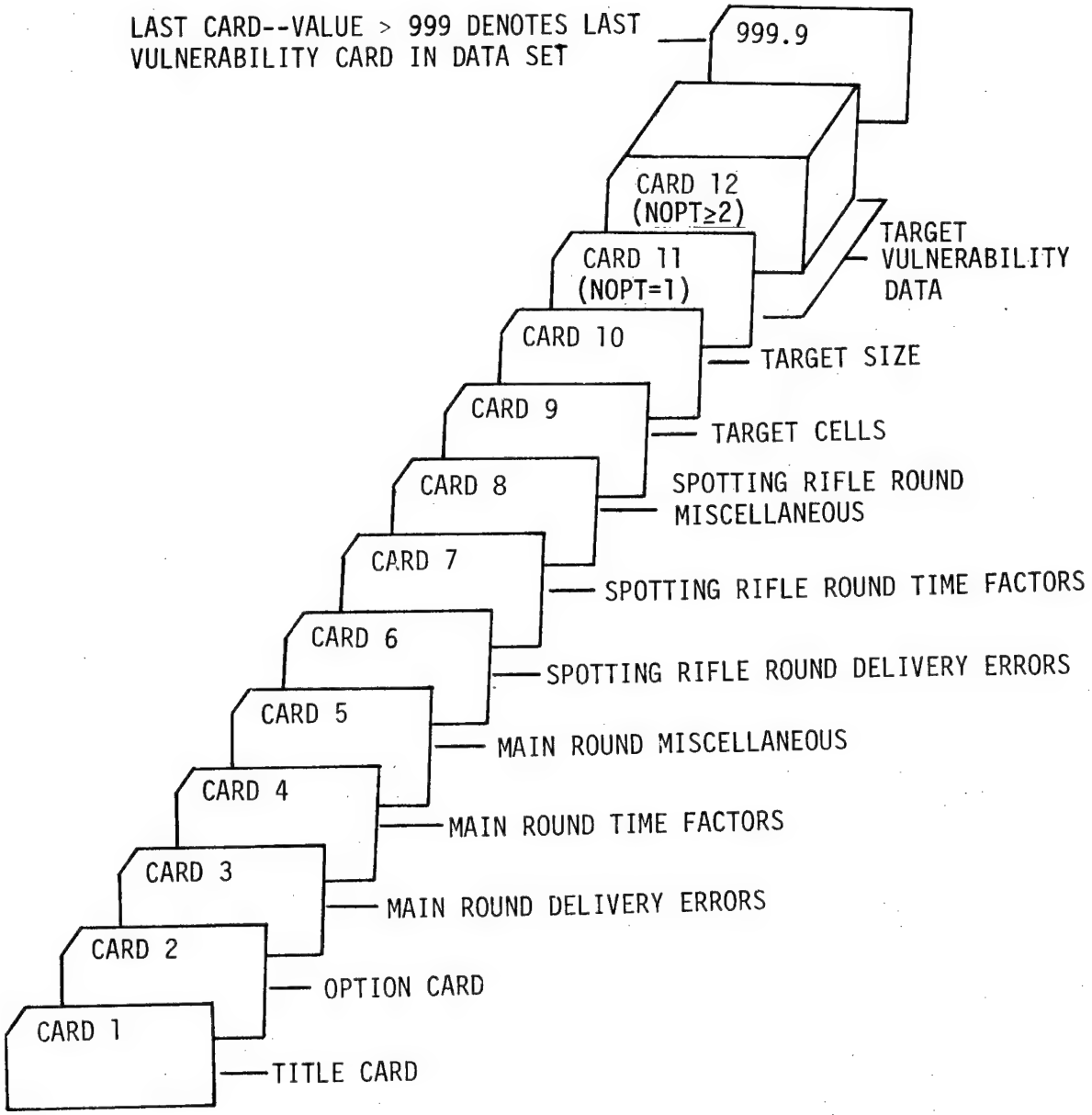

Figure 5-1. Data Deck Assembly

Title Card				CARD: 1	
	A				
ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	CASE	---	40A2	1-80	Title of run.

CARD: 1

Option Card | CARD: 2

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NOPT1	---	I5	1-5	Flag governing program options: NOPT1=1: fire only main rounds in samples; NOPT1=2: fire spotting rifle and main rounds; NOPT1=3: fire only one main round per sample.
B	NRDS	---	I5	6-10	Number of main rounds to be fired per sample.
C	NOPT	---	I5	11-15	Flag controlling execution of target array setup: NOPT=0: target arrays remain as in previous run; NOPT=1: standard target array setup; NOPT≥2: standard target orientation is reversed.
D	---	---	5X	16-20	Blank.
E	XC	meters	F10.2	21-30	Intended horizontal aim center of target.
F	YC	meters	F10.2	31-40	Intended vertical aim center of target.
G	SXS	meters	F10.2	41-50	Standard deviation of horizontal sensing error for main rounds.
H	SYS	meters	F10.2	51-60	Standard deviation of vertical sensing error for main rounds.
I	SXB	meters	F10.2	61-70	Standard deviation of horizontal variable bias for main rounds.
J	SYB	meters	F10.2	71-80	Standard deviation of vertical variable bias for main rounds.

CARD: 2

Main Round Delivery Errors | CARD: 3

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	SXR	meters	F10.2	1-10	Standard deviation of horizontal random error for main rounds.
B	SYR	meters	F10.2	11-20	Standard deviation of vertical random error for main rounds.
C	PRS	---	F10.2	21-30	Probability of sensing main round miss.
D	REL	---	F10.2	31-40	Main round reliability.
E	YDEF	inches	F10.2	41-50	Vertical defiladed coordinate.
F	XB	meters	F10.2	51-60	Horizontal fixed bias for main rounds.
G	YB	meters	F10.2	61-70	Vertical fixed bias for main rounds.
H	FLT	seconds	F10.2	71-80	Projectile time of flight of main round.

CARD: 3

Main Round Time Factors

CARD: 4

A B C D E F G H

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	TF1	seconds	F10.2	1-10	Fixed median time for first main round.
B	TFS	seconds	F10.2	11-20	Fixed median time for main rounds subsequent to first round.
C	XM1	seconds	F10.2	21-30	Variable median time for first main round.
D	XM2	seconds	F10.2	31-40	Variable median time for main rounds subsequent to the first round.
E	AMT1	seconds	F10.2	41-50	Minimum time for first main round.
F	AMT2	seconds	F10.2	51-60	Minimum time for main rounds subsequent to the first round.
G	ST1	---	F10.2	61-70	Slope of time distribution for first main round.
H	ST2	---	F10.2	71-80	Slope of time distribution for main rounds subsequent to the first round.

CARD: 4

Main Round, Miscellaneous

CARD: 5

A B C D

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	SIGXL	meters	F10.2	1-10	Standard deviation of horizontal lay error for main rounds.
B	SIGYL	meters	F10.2	11-20	Standard deviation of vertical lay error for main rounds.
C	RELF	---	F10.2	21-30	Main round fuze reliability.
D	PASSN	---	F10.2	31-40	Target passengers (data field applicable for APC type of target).

CARD: 5

Spotting Rifle Round Delivery Errors — CARD: 6

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NRDS1	---	I5	1-5	Number of spotting rifle rounds to be fired per sample.
B	---	---	5X	6-10	Blank.
C	SXS1	meters	F10.2	11-20	Standard deviation of horizontal sensing error for spotting rounds.
D	SYS1	meters	F10.2	21-30	Standard deviation of vertical sensing error for spotting rounds.
E	SXB1	meters	F10.2	31-40	Standard deviation of horizontal variable bias for spotting rounds.
F	SYB1	meters	F10.2	41-50	Standard deviation of vertical variable bias for spotting rounds.
G	SXR1	meters	F10.2	51-60	Standard deviation of horizontal random error for spotting rounds.
H	SYR1	meters	F10.2	61-70	Standard deviation of vertical random error for spotting rounds.
I	PRS1	---	F10.2	71-80	Probability of sensing missing spotting rounds.

CARD: 6

Spotting Round Time Factors

CARD: 7

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XB1	meters	F10.2	1-10	Horizontal fixed bias for spotting rounds.
B	YB1	meters	F10.2	11-20	Vertical fixed bias for spotting rounds.
C	FLT1	seconds	F10.2	21-30	Projectile time of flight for spotting rounds.
D	TF11	seconds	F10.2	31-40	Fixed median time for first spotting round.
E	TFS1	seconds	F10.2	41-50	Fixed median time for spotting rounds subsequent to first round.
F	XM11	seconds	F10.2	51-60	Variable median time for first spotting round.
G	XM21	seconds	F10.2	61-70	Variable median time for spotting rounds subsequent to first round.
H	AMT11	seconds	F10.2	71-80	Minimum time for first spotting round.

CARD: 7

Spotting Round, Miscellaneous — CARD: 8

A B C D E

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	AMT21	seconds	F10.2	1-10	Minimum time for spotting rounds subsequent to the first round.
B	ST11	---	F10.2	11-20	Slope of time distribution for first spotting round.
C	ST21	---	F10.2	21-30	Slope of time distribution for spotting rounds subsequent to the first round.
D	SIGXL1	meters	F10.2	31-40	Standard deviation of horizontal lay error for spotting rounds.
E	SIGYL1	meters	F10.2	41-50	Standard deviation of vertical lay error for spotting rounds.

CARD: 8

Target Cell					CARD: 9
	A 1 2 3 4 5	B 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80			
ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NX	---	I5	1-5	Number of target cells in horizontal direction.
B	NY	---	I5	6-10	Number of target cells in vertical direction.

CARD: 9

Target Size | CARD: 10

A B C D

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XMIN	inches	F10.1	1-10	Minimum horizontal value of grid area enveloping target.
B	YMIN	inches	F10.1	11-20	Minimum vertical value of grid area enveloping target.
C	DX	inches	F10.1	21-30	Target cell size in the horizontal direction.
D	DY	inches	F10.1	31-40	Target cell size in the vertical direction.

CARD: 10

Target Pk's (NOPT=1)					CARD: 11
	A	B	C	D	E	F	G	H

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	X	inches	F7.2	1-7	Horizontal target coordinate.
B	Y	inches	F7.2	8-14	Vertical target coordinate.
C	---	---	6X	15-20	Blank.
D	Pk(1, 1)	---	F7.1	21-27	Target Pk for kill criterion 1.
E	Pk(1, 2)	---	F7.1	28-34	Target Pk for kill criterion 2.
F	Pk(1, 3)	---	F7.1	35-41	Target Pk for kill criterion 3.
G	Pk(1, 4)	---	F7.1	42-48	Target Pk for kill criterion 4.
H	Pk(1, 5)	---	F7.1	49-55	Number of target passengers killed.
					(Pk(I, J), $I \leq 3000$; $J \leq 5$)

CARD: 11

Target Pk's (NOPT≥2) | CARD: 12

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	X	inches	F7.2	1-7	Horizontal target coordinate.
B	Y	inches	F7.2	8-14	Vertical target coordinate.
C	---	---	38X	15-52	Blank.
D	Pk(1, 1)	---	F7.1	53-59	Target Pk for kill criterion 1.
E	Pk(1, 2)	---	F7.1	60-66	Target Pk for kill criterion 2.
F	Pk(1, 3)	---	F7.1	67-73	Target Pk for kill criterion 3.
G	Pk(1, 4)	---	F7.1	74-80	Target Pk for kill criterion 4.

(Pk(I, J), $I \leq 3000$; $J \leq 4$)

CARD: 12

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SECTION VI

SAMPLE CASE OUTPUT

This section contains a sample problem with a data checksheet (Figure 6-1) to illustrate the input variables which are printed out in Figure 6-2 in the same order as they appear in Figure 6-1. Although there are over 1,000 vulnerability cards required for this particular sample case, only a representative few are shown in Figure 6-2. (The entire vulnerability card deck appears in Appendix A.) This section also provides samples of the output data formats.

DATA CHECKSHEET

CARD ID	PG	PARAM	VALUE
1		CASE	RANGE =
			250
			METERS
			NON-
			DEFILADED
2		NOPT1	1
		NRDS	3
		NOPT	1
		XC	0.0
		YC	0.0
		SXS	0.0
		SYS	0.0
		SXB	.1240
		SYB	.1397
3		SXR	.3208
		SYR	.3208
		PRS	0.0
		REL	1.0
		YDEF	-999.0
		XB	-.5293
		YB	-.4430
		FLT	2.0
4		TF1	0.0
		TFS	0.0
		XM1	15.0
		XM2	15.0
		AMT1	0.0
		AMT2	0.0
		ST1	0.0
		ST2	0.0

CARD ID	PG	PARAM	VALUE
5		SIGXL	0.0
		SIGYL	0.0
		RELF	1.0
		PASSN	0.0
6		NX	200.0
		NY	50.0
7		XMIN	-402.0
		YMIN	-102.0
		DX	4.0
		DY	4.0
8		X	24.0
		Y	84.0
		KILL CRIT #1	0.0
		KILL CRIT #2	0.0
		KILL CRIT #3	0.0
		KILL CRIT #4	0.0
9 - 1132		(Refer to	
		Appendix A)	

Figure 6-1. Sample Case Input Data Sheet

```
RANGE = 250 METERS   NON DEFILADED
    1     3     1          0.          0.          0.          0.          .124        .1397
.3208           .3208      0.          1.       -999.       -.5293      -.4430         2.
0.              0.         15.         15.         0.          0.          0.          0.
0.              0.         1.
  200    50
-202.           -102.      4.          4.
  24.0    84.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  24.0    44.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  40.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  36.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  32.0    32.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  28.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  24.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   4.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   0.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -44.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -48.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -52.0    32.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  44.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  40.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  36.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  32.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  28.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  24.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  20.0    28.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  16.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  12.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   8.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   4.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   0.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  -4.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  -8.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -48.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -52.0    28.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  48.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  44.0    24.0           .987   .998   .998   .798       0.000  0.000  0.000  0.000
  40.0    24.0           .987   .998   .998   .798        .987   .998   .998   .798
  36.0    24.0           .987   .998   .998   .798        .987   .998   .998   .798
  32.0    24.0          0.000  0.000  0.000  0.000       1.000  1.000  1.000  1.000
  28.0    24.0          1.000  1.000  1.000  1.000       1.000  1.000  1.000  1.000
  24.0    24.0          1.000  1.000  1.000  1.000       1.000  1.000  1.000  1.000
  20.0    24.0          0.000  0.000  0.000  0.000       1.000  1.000  1.000  1.000
  16.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  12.0    24.0          0.000  0.000  0.000  0.000        .987   .998   .998   .798
   8.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   4.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
   0.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  -4.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
  -8.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -12.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -16.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -20.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -32.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
 -36.0    24.0          0.000  0.000  0.000  0.000        .987   .998   .998   .798
 -44.0    24.0          0.000  0.000  0.000  0.000       0.000  0.000  0.000  0.000
```

Figure 6-2. Sample Case Card Input Print-out

PRINTED OUTPUT

The printed data include various input data parameters; closed form solutions for Ph single round data; mean target Pk, mean target Ph, mean time Pk, and mean time Ph data; and the average number of rounds fired per case.

Input Data Listing

The data listed in Figure 6-3 represents input data parameters including the run title, program and input option flag indicators, number of main rounds fired per sample, the system and random delivery errors in the horizontal and vertical directions, the probability of a missing round being sensed, round reliability, the vertical defilading coordinate, and fuze reliability. Time data including projectile time of flight and crew proficiency time factors are followed by the number of Monte Carlo trials run and the results of the closed form solution to the probabilities of hitting the target for a single main round and for a single main round given a sensed miss.

Target Results

The first 10 rows of column 1 in Figure 6-4 indicate the number of rounds fired per Monte Carlo trial. The next four columns of 10 rows represent the mean target Pk values for the designated kill criteria. Mean target Ph data are presented in column 7 in which the first answer for one round fired per sample should show agreement with the results of the closed form solution. Row 11 of columns 1 and 2 depict the number of times throughout the samples that all the specified maximum number of spotting rifle rounds were fired and the average number of spotting rounds fired per trial.

For those APC target data sets including passenger kill information, column 5 is used to print the results of the average number of personnel casualties per rounds fired.

```
RANGE = 250 METERS  NON DEFILADED


      SIMULATION =     1
NUMBER OF ROUNDS =    10
NOPT =     1

                                HORIZONTAL    VERTICAL

                                   METERS       METERS

SENSING ERRORS (STD DEV)           0.0          0.0
VARIABLE BIAS (STD DEV)            0.1240       0.1397
RANDOM ERRORS (STD DEV)            0.3208       0.3208
FIXED BIAS                        -0.5293      -0.4430
AIM CENTER                         0.0          0.0
LAY ERROR                          0.0          0.0

PROBABILITY OF SENSING MISSING ROUND =    0.0
RELIABILITY OF ROUND =    1.000000
VERTICAL DEFILADED COORDINATES =  -999.000000 INCHES
RELIABILITY OF FUZE =                        1.000000


                                TIME DATA(SECS)

TIME OF FLIGHT =    2.000000

                                1ST ROUND          SUBSEQUENT RDS.

FIXED MEDIAN TIME                  0.0                  0.0
VARIABLE MEDIAN TIME              15.000000            15.000000
MINIMUM TIME                       0.0                  0.0
SLOPE OF DISTRIBUTION              0.0                  0.0

PROB. OF HIT OF FIRST ROUND =        0.9954607
PROB. OF HIT/SENSED MISS =         0.9464230


NUMBER OF SAMPLES =   9604
```

Figure 6-3. Sample Case Input Data Print-out

TARGET KILL CRITERIA

NROS	NO. 1 $\overline{Pk}_1$	NO. 2 $\overline{Pk}_2$	NO. 3 $\overline{Pk}_3$	NO. 4 $\overline{Pk}_4$		Target $\overline{Ph}$
1	0.7229279	0.6665972	0.7338608	0.5867347	0.0	0.9958349
2	0.9203456	0.8832777	0.9246147	0.8278841	0.0	0.9999999
3	0.9801124	0.9593918	0.9818825	0.9282590	0.0	0.9999999
4	0.9930236	0.9819866	0.9936484	0.9668887	0.0	0.9999999
5	0.9977092	0.9917741	0.9978133	0.9844856	0.0	0.9999999
6	0.9991669	0.9960432	0.9992710	0.9919824	0.0	0.9999999
7	0.9996876	0.9984381	0.9996876	0.9969803	0.0	0.9999999
8	0.9997917	0.9993752	0.9997917	0.9990628	0.0	0.9999999
9	0.9998958	0.9996876	0.9998958	0.9994793	0.0	0.9999999
10	0.9998958	0.9996876	0.9998958	0.9995834	0.0	0.9999999
0	0←(Average number of spotting rifle rounds fired per trial)					

(Number of times throughout the samples that all the specified number of spotting rifle rounds were fired)

Figure 6-4. Mean Pk Results

Time Results

For the given kill criteria, each of the elements of the time Pk arrays listed in Figure 6-5 represents a 2-second interval from time 0 to 120 seconds reading from left to right. The mean time Pk arrays for the various kill criteria are ordered sequentially with the first array denoting the first kill criterion, etc. However, the sixth array is associated with column 7 of the target results and pertains to mean Ph time data.

Round Expenditure

The final output results concerning the average number of main rounds fired to achieve a kill per case are shown in Figure 6-6. The last case represents the average number of rounds to merely hit the target.

Time Pk Array for Kill Criterion 1 (0-120 Seconds)

```
0.0     0.0     0.0     0.00260 0.02405 0.07486 0.14931 0.23719 0.32309 0.40254
0.47053 0.53405 0.59298 0.64202 0.68347 0.71855 0.75531 0.78488 0.80789 0.83090
0.84944 0.86724 0.88286 0.89733 0.90816 0.91681 0.92774 0.93419 0.94242 0.95033
0.95637 0.96147 0.96533 0.96855 0.97220 0.97470 0.97709 0.97959 0.98188 0.98407
0.98573 0.98698 0.98875 0.99052 0.99167 0.99209 0.99344 0.99406 0.99448 0.99531
0.99583 0.99625 0.99677 0.99688 0.99750 0.99781 0.99813 0.99833 0.99854 0.99865
0.99885
```

Time Pk Array for Kill Criterion 2 (0-120 Seconds)

```
0.0     0.0     0.0     0.00187 0.02166 0.06799 0.13723 0.21949 0.29988 0.37328
0.43669 0.49573 0.55144 0.59850 0.63921 0.67368 0.71127 0.74136 0.76510 0.78946
0.81018 0.82861 0.84527 0.86131 0.87453 0.88505 0.89817 0.90650 0.91660 0.92420
0.93180 0.93857 0.94419 0.94877 0.95325 0.95731 0.96210 0.96564 0.96887 0.97189
0.97459 0.97678 0.97918 0.98126 0.98386 0.98428 0.98563 0.98667 0.98803 0.98928
0.99063 0.99105 0.99209 0.99292 0.99334 0.99386 0.99427 0.99459 0.99500 0.99594
0.99625
```

Time Pk Array for Kill Criterion 3 (0-120 Seconds)

```
0.0     0.0     0.0     0.00260 0.02436 0.07580 0.15160 0.24063 0.32799 0.40848
0.47720 0.54102 0.59985 0.64890 0.69023 0.72511 0.76145 0.79134 0.81331 0.83611
0.85454 0.87182 0.88713 0.90108 0.91139 0.91982 0.93076 0.93711 0.94544 0.95262
0.95866 0.96366 0.96741 0.97032 0.97376 0.97626 0.97865 0.98095 0.98313 0.98532
0.98698 0.98823 0.98990 0.99177 0.99292 0.99323 0.99406 0.99469 0.99511 0.99594
0.99646 0.99667 0.99719 0.99719 0.99761 0.99792 0.99823 0.99844 0.99865 0.99875
0.99896
```

Time Pk Array for Kill Criterion 4 (0-120 Seconds)

```
0.0     0.0     0.0     0.00156 0.01853 0.06029 0.12099 0.19336 0.26395 0.32997
0.38776 0.44138 0.49386 0.53873 0.57820 0.61329 0.65025 0.68201 0.70929 0.73449
0.75625 0.77707 0.79394 0.81195 0.82799 0.84059 0.85579 0.86662 0.87953 0.88848
0.89838 0.90764 0.91524 0.92149 0.92763 0.93326 0.93888 0.94461 0.95002 0.95398
0.95793 0.96137 0.96481 0.96751 0.97137 0.97251 0.97543 0.97678 0.97855 0.98022
0.98209 0.98356 0.98501 0.98636 0.98740 0.98803 0.98907 0.98969 0.99084 0.99209
0.99261
```

```
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0
```

Time Ph Array (0-120 Seconds)

```
0.0     0.0     0.0     0.00375 0.03374 0.10235 0.20429 0.32507 0.44086 0.54894
0.63515 0.71064 0.77468 0.82257 0.86141 0.89036 0.91451 0.93388 0.94648 0.95845
0.96699 0.97386 0.98063 0.98396 0.98698 0.98896 0.99115 0.99188 0.99344 0.99459
0.99563 0.99625 0.99688 0.99740 0.99771 0.99792 0.99844 0.99875 0.99885 0.99917
0.99927 0.99938 0.99969 0.99969 0.99979 0.99979 0.99979 0.99979 0.99979 0.99979
0.99979 0.99979 0.99990 0.99990 0.99990 0.99990 0.99990 0.99990 0.99990 0.99990
0.99990
```

Figure 6-5. Mean Time Pk Results

			Kill Criteria
AVG. NO. RDS =	1.39	CASE = 1	NO. 1
AVG. NO. RDS =	1.52	CASE = 2	NO. 2
AVG. NO. RDS =	1.37	CASE = 3	NO. 3
AVG. NO. RDS =	1.72	CASE = 4	NO. 4
AVG. NO. RDS =	0.0	CASE = 5	---
AVG. NO. RDS =	1.00	CASE = 6	Ph

Figure 6-6. Case Rounds Fired

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SECTION VII

SOURCE LISTING

The following section contains the source listings for the MAIN Routine, Subroutine INPUT, Subroutine KILRAT, Function RANDOM, and Subroutine SSHOT presented in Figures 7-1 through 7-7.

```
C*****************************************************************************
C
C    JMEM/SS MODEL FOR DIRECT FIRE
C
C    MAIN PROGRAM
C    PURPOSE
C    LOCATES IMPACT POINTS OF MAIN AND SPOTTING RIFLE ROUNDS; MONITORS
C    THE TIME TO KILL; COMPUTES PK AND PH TARGET DATA AND PK AND PH TIME DATA
C
C*****************************************************************************
C
C    SUBPROGRAMS REQUIRED
C    INPUT- READS INPUT DATA.
C    KILRAT- COMPUTES AND WRITES THE AVERAGE NUMBER OF MAIN ROUNDS FIRED
C    PER CASE.
C    NRAN31- PROVIDES NORMAL DEVIATES FOR MONTE CARLO SAMPLING
C    RANDOM-UNIFORM RANDOM NUMBER GENERATOR.
C    SSHOT- COMPUTES PH FOR A SINGLE MAIN ROUND AND PH FOR A SINGLE ROUND
C    GIVEN A SENSED MISS USING A CLOSED FORM SOLUTION.
C
C*****************************************************************************
C
      DIMENSION PK(3000 ,8),AX(201),AY(51 ),Z(19 ,9),C(8),Z1(61 )
      COMMON PK,AX,AY,SIGXR,SIGYR,SIGXB, SIGYB,SIGXS,SIGYS,PROBS,XB,YB,
     1XC,YC,REL,TF1,TFS,XM1,XM2,YDEF,NOPT1,NRDS,NX,NY,FLT,ST1,ST2,AMT1,
     2AMT2,IK(50,200),Z,Z1 ,AKIL(61,9),SIGXL,SIGYL,RELF
     3,SIGXS1,SIGYS1,SIGXB1,SIGYB1,SIGXR1,SIGYR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
      COMMON/ RANDM/I1
C
C    SET I1= TO ANY ODD NUMBER FOR RANDOM SEED.
C
      I1=11111111
C
C    READ INPUT
C
 2    CALL INPUT
C
C    COMPUTE PROBABILITY OF HIT OF FIRST ROUND AND PROBABILITY OF HIT GIVEN
C    A SENSED MISS IN A CLOSED FORM SOLUTION AND WRITE RESULTS.
C
      CALL SSHOT(PCH,PCH1)
      WRITE(6,60) PCH,PCH1
 60   FORMAT(/31H PROB. OF HIT OF FIRST ROUND = ,F16.7,/28H PROB. OF HIT
     1/SENSED MISS = ,F16.7)
C
C    INITIALIZE SAMPLE SIZE.
C
      NSAMP=9604
C
C    INITIALIZE TIME ARRAY AND PROBABILITY ARRAY.
C
      DO95J=1,6
      DO158I=1,61
 158  AKIL(I,J)=0.
      DO 95 I=1,NRDS
```

Figure 7-1. Source Listing, MAIN Routine (1 of 7)

```
 95   Z(I,J)=0.
C
C   PRINT OUT SAMPLE SIZE.
C
      WRITE(6,62)NSAMP
C
C   START SAMPLING
C
      TH12=0
      TH13=0
      DO 99 I=1,NSAMP
C
C   INITIALIZE VARIABLES FOR EACH SAMPLE.
C
      SUMCAS =0.
      XC1=0.
      YC1=0.
      TH10=0
      TH11=0
      T=0.
      THW=0
      DO94J=1,8
 94   C(J)=0.
C
C   IF ONLY MAIN ROUNDS CONSIDERED GO TO 201.
C
      IF(NOPT1.NE.2)GOTO201
      CALL NRAN31(R1,R2)
C
C   SET T TO TIME OF FLIGHT OF ONE SPOTTING RIFLE SHOT.
C
      T=FLT1
C
C   XC1,YC1 IS CENTER OF IMPACT FOR FIRST ROUND OF SPOTTING RIFLE SHOTS.
C
      XC1=R1*SIGXB1+XC+XB1
      YC1=R2*SIGYB1+YC+YB1
      FAC=1.
C
C   DRAW NORMAL DEVIATES FOR RANDOM AND LAY ERRORS OF SPOTTING RIFLE.
C
 200  CALL NRAN31(R1,R2)
      CALL NRAN31(R3,R4)
C
C   TH11 IDENTIFIES THE SPOTTING RIFLE ROUNDS.
C
      TH11=TH11+1
C
C   DRAW NORMAL DEVIATES FOR TIME FOR SPOTTING RIFLE.
C
      CALL NRAN31(T1,T2)
C
C   FOR FIRST ROUND TIME OF SPOTTING RIFLE GO TO 210.
C
      IF(TH11.EQ.1)GOTO210
C
```

Figure 7-1. Source Listing, MAIN Routine (2 of 7)

```
C    FOR SUBSEQUENT ROUND TIMES.
C
       HWM=XM21*EXP(T1*ST21)
       IF(HWM.LE.AMT21) HWM=AMT21
       T=T+HWM+TFS1
       GOTO211
 210   HWM=XM11*EXP(T1*ST11)
       IF(HWM.LE.AMT11) HWM=AMT11
       T=T+HWM+TF11
 211   CONTINUE
C
C    IMPACT POINT FOR THIS SPOTTING RIFLE SHOT.
C
       X1=XC1+R1*SIGXR1+R3*SIGXL1*FAC
       Y1=YC1+R2*SIGYR1+R4*SIGYL1*FAC
C
C    GO SEE IF THIS SHOT HIT.
C
       GOTO160
C
C    DRAW RANDOM DEVIATES FOR VARIABLE BIAS ERRORS FOR FIRST MAIN ROUND.
C
 201   CALL NRAN31(R1,R2)
C
C    UPDATE TIME BY FLIGHT TIME OF MAIN ROUND.
C
       T=T+FLT
C
C    UPDATE CENTER OF IMPACT FOR MAIN ROUNDS.
C
       XC1=R1*SIGXB+XC+XB+XC1
       YC1=R2*SIGYB+YC+YB+YC1
C
C    FAC IS A FACTOR TO INCLUDE LAY ERROR IF IT IS 1.
C
       FAC=1.
C
C    ENTER MAIN ROUND LOOP.
C
       J=0
 985   J=J+1
C
C    IH10 IS A SWITCH TO TELL IF THIS IS MAIN ROUND OR NOT. IH10=1 IS MAIN
C    ROUND.
C
       IH10=1
       IH20=0
C
C    SAMPLE IMPACT POINT FOR THIS ROUND
C
       IF(FAC.EQ.0.)GOTO101
C
C    IF ROUND HAS BEEN SENSED BEFORE, EXCLUDE THE LAY ERROR.
C
       CALL NRAN31(R1,R2)
       X2=SIGXL*R1
```

Figure 7-1. Source Listing, MAIN Routine (3 of 7)

```
      Y2=SIGYL*R2
  101 CALL NRAN31(R1,R2)
C
C     FIND IMPACT POINT OF THIS MAIN ROUND.
C
      X1=XC1+R1*SIGXR+FAC*X2
      Y1=YC1+R2*SIGYR+FAC*Y2
C
C     UPDATE THE TIME FOR THIS MAIN ROUND.
C
      CALL NRAN31(T1,T2)
      IF(J.EQ.1)GOTO159
      HWM=XM2*EXP(T1*ST2)
      IF(HWM.LE.AMT2) HWM=AMT2
      T=T+HWM+TFS
      GOTO160
  159 HWM=XM1*EXP(T1*ST1)
      IF(HWM.LE.AMT1) HWM=AMT1
      T=T+HWM+TF1
C
C     IS TARGET DEFILADED?
C
  160 IF(Y1.LT.YDEF) GO TO 1
C
C     IS THIS ROUND WITHIN VULNERABILITY MATRIX?
C
      IF(X1.LT.AX(1    ))GOTO1
      IF(X1.GT.AX(NX+1))GOTO1
      IF(Y1.LT.AY(1    ))GOTO1
      IF(Y1.GT.AY(NY+1))GOTO1
C
C     WHERE IS THIS ROUND IN THE VULNERABILITY MATRIX?
C
      J1=1
    3 J1=J1+1
      IF(X1.GT.AX(J1))GOTO3
      J1=J1-1
   31 J2=1
    4 J2=J2+1
      IF(X1.GT.AX(J2))GOTO4
      J2=J2-1
C
C     IS THIS ROUND A HIT?
C
      IF(IK(J1,J2).LE.0 )GOTO1
C
C     IF THIS IS A SPOTTING RIFLE HIT UPDATE NUMBER OF ROUNDS IT TOOK AND
C     START FIRING THE MAIN ROUND.
C
      IF(IH10.EQ.0) IH13=IH13+IH11
      IF(IH10.EQ.0)GOTO204
C
C     IS THIS HIT A RELIABLE ROUND?
C
      IF(RANDOM( 1).GT.REL)GOTO97
C
```

Figure 7-1. Source Listing, MAIN Routine (4 of 7)

```
C    IF THIS HIT IS NOT THE FIRST HIT GO TO 55
C
       IF(THW.GT.0)GOTO55
C
C    UPDATE THE PROBABILITY ARRAY AND TIME ARRAY FOR THIS HIT.
C
       THW=1
       J10=J
       DO51K=J10,NRDS
  51   Z(K,6)=Z(K,6)+1.
       J10=2.+T/2.
       IF(J10.GT.61)GOTO55
       DO151J11=J10,61
 151   AKIL(J11,6)=AKIL(J11,6)+1.
C
C    DOES THIS HIT HAVE A RELIABLE FUZE?
C
  55   IF(RANDOM(1).GT.RELF)GOTO97
       TH20=1
C
C    IS THIS HIT A KILL?
C
       HW2=RANDOM(1)
       K22=IK(J1,J2)
       HW1=0.
C
C    4 DIFFERENT KILL CRITERIA ARE CONSIDERED.
C
       DO93K21=1,4
       IF(C(K21).GT.0.)GOTO93
       IF(PK(K22,K21).LT.HW2)GOTO92
C
C    IF THIS HIT IS A KILL FOR THIS CRITERION UPDATE PROBABILITY ARRAY AND
C     TIME ARRAY.
C
       J10=2.+T/2.
       IF(J10.GT.61)GOTO152
       DO153J11=J10,61
  153  AKIL(J11,K21)=AKIL(J11,K21)+1.
  152  DO42K20=J,NRDS
  42   Z(K20,K21)=Z(K20,K21)+1.
       C(K21)=1.
       GOTO93
  92   HW1=1.
  93   CONTINUE
C
C    IF THIS ROUND WAS NOT A KILL FOR ALL CRITERIA GO FIRE ANOTHER ROUND.
C
       IF(HW1.GT.0.)GOTO97
       IF(PASSN.GT.0.)GOTO97
C
C    IF THIS ROUND IS A KILL FOR ALL CRITERIA GO TO NEXT SAMPLE.
C
       GOTO99
C
C    IF THIS IS THE MAIN ROUND GO TO 203
```

Figure 7-1. Source Listing, MAIN Routine (5 of 7)

```
C
 1    IF(TH10.NE.0)GOTO203
C
C   IF THE SPOTTING RIFLE HAS SHOT MORE OR EQUAL TO THE SPECIFIED ROUNDS.
C
      IF(TH11.GE.NRDS1)GOTO206
C
C   WAS THIS ROUND SENSED?
C
      IF(RANDOM(1).GT.PR  S1)GOTO200
C
C   CORRECT CI IN PARALLELOGRAM FASHION.
C
      CALL NRAN31(R1,R2)
      XC1=XC1-X1+XC-R1*SIGXS1
      YC1=YC1-Y1+YC-R2*SIGYS1
      FAC=0.
C
C   FIRE ANOTHER SPOTTING ROUND.
C
      GOTO200
C
C   CORRECT THE CENTER OF TARGET OUT OF CENTER OF IMPACT BECAUSE IT WILL
C   BE ADDED IN WHEN MAIN ROUND IS FIRED.
C
 204  XC1=XC1-XC
      YC1=YC1-YC
      GOTO201
 206  TH12=TH12+1
      TH13=TH13+TH11
C
C   IF ALL OF SPOTTING RIFLE ROUNDS HAVE BEEN FIRED AND ROUND IS NOT WITH
C   IN 12 INCHES OF TARGET GO TO NEXT SAMPLE OTHERWISE FIRE MAIN ROUND.
C
      IF(AX(1 )-12..GT.X1) GOTO99
      IF(AX(NX)+12..LT.X1) GOTO99
      IF(AY(NY)+12..LT.Y1) GOTO99
      IF(AY(1 )-12..GT.Y1) GOTO99
      GOTO204
C
C   IF THE MISS OF THE MAIN ROUND IS NOT SENSED FIRE ANOTHER ROUND WITH
C   NO CORRECTION.
C
 203  IF(RANDOM(1).GT.PROBS) GO TO 97
C
C   CORRECT CI FOR NEXT ROUND USING PARALLELOGRAM METHOD.
C
      CALL NRAN31(R1,R2)
      XC1=XC1-X1+XC-R1*SIGXS
      YC1=YC1-Y1+YC-R2*SIGYS
      FAC=0.
 97   CONTINUE
      IF(PASSN.LE.0.)GOTO98
C
C   CHECK FUZE ACTUATION.
C
```

Figure 7-1. Source Listing, MAIN Routine (6 of 7)

```
      IF(IH20.EQ.0)GOTO302
C
C   PERSONNEL CASUALTIES COMPUTED.
C
      SUMCAS =SUMCAS +(PK(K22,5)/PASSN)*(PASSN-SUMCAS )
 302  Z(J,5)=Z(J,5)+SUMCAS
 98   CONTINUE
C
C   FIRE NEXT MAIN ROUND.
C
      IF(J.LT.NRDS)GOTO985
C
C   GO TO NEXT SAMPLE.
C
 99   CONTINUE
C
C   SAMPLING IS COMPLETE.
C
      WRITE(6,7)
 7    FORMAT(//12H NRDS      PK/)
C
C   COMPUTE MEAN PK AND PH TARGET DATA AND WRITE RESULTS.
C
      SAMP=NSAMP
      SAMPI=1./SAMP
      DO 96 I2=1,NRDS
      DO91I=1,6
 91   Z(I2,I)=Z(I2,I)*SAMPI
 87   WRITE(6,6)I2,(Z(I2,I),I=1,6)
 96   CONTINUE
      IH13=IH13/NSAMP
C
C   IH12 IS NUMBER OF TIMES FIRED ALL SPOTTING ROUNDS, IH13 IS AVERAGE
C   NUMBER OF SPOTTING ROUNDS FIRED.
C
      WRITE(6,251) IH12,IH13
 251  FORMAT(2I5)
C
C   COMPUTE MEAN PK AND PH TIME DATA AND WRITE RESULTS.
C
      WRITE(6,61)
      DO154I=1,61
      DO154J=1,6
 154  AKTL(I,J)=AKTL(I,J)*SAMPI
      DO155I=1,6
      WRITE(6,156)(AKTL(I,J),I=1,61)
 156  FORMAT(10F8.5)
      WRITE(6,157)
 157  FORMAT(1H0)
 155  CONTINUE
C
C   COMPUTE AVERAGE NO. OF RDS. FIRED.
C
      IF(NOPT1.EQ.3)GOTO2
      CALL KILRAT
C
C   GO TO READ NEXT DATA SET.
C
      GOTO2
 6    FORMAT(I5,  9F13.7)
 61   FORMAT(1H1)
 62   FORMAT(//21H NUMBER OF SAMPLES = ,I6,/1H1)
      END
```

Figure 7-1. Source Listing, MAIN Routine (7 of 7)

```
      FUNCTION CNF(X)
C*****************************************************************************
C    PURPOSE
C    COMPUTES CUMULATIVE NORMAL DISTRIBUTION VALUES FOR CELL PH USED
C    IN CLOSED FORM SOLUTION.
C*****************************************************************************
C
      F=0.
      AX=ABS(X)*.7071068
      IF(AX.GE.5.)GOTO3
      F=.5-.5*ERF(AX)
3     IF(X.GE.0.)F=1.-F
      CNF=F
      RETURN
      END
```

Figure 7-2. Source Listing, Function CNF(X)

```
      SUBROUTINE INPUT
C*****************************************************************************
C    PURPOSE.
C    READ AND WRITE INPUT DATA, CONVERT UNITS OF INPUT DATA, AND SET UP
C    THE TARGET GRID AND PK ARRAYS.
C*****************************************************************************
C
      DIMENSION PK(3000 ,8),AX(201),AY(51 ),CASE(40),Z(19,9),Z1(61)
      COMMON PK,AX,AY,SXR,SYR,SXB,SYB,SXS,SYS,PRS,XB,YB,XC,YC,REL,TF1,
     1TFS,XM1,XM2,YDEF,NOPT1,NRDS,NX,NY,FLT,ST1,ST2,AMT1,AMT2,TK(50,200)
     2,Z,Z1,AKIL(61,9),SIGXL,SIGYL,RELF
     3,S  XS1,S  YS1,S  XB1,S  YB1,S  XR1,S  YR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
C
C  READ AND WRITE TITLE CARD.
C
      READ(5,20,END=6) CASE
 20   FORMAT(40A2)
      WRITE(6,18) CASE
 18   FORMAT(1H1,40A2)
C
C    READ MAIN ROUND DATA.
C
      READ(5,1,END=6)NOPT1,NRDS,NOPT,XC,YC,SXS,SYS,SXB,SYB,SXR,SYR,PRS,R
     1EL,YDEF,XB,YB,FLT,TF1,TFS,XM1,XM2,AMT1,AMT2,ST1,ST2,SIGXL,SIGYL,
     2RELF,PASSN
C
C    CHECK FLAG TO READ SPOTTING ROUND DATA.
C
      IF(NOPT1.NE.2)GOTO201
      READ(5,204)NRDS1,SXS1,SYS1,SXB1,SYB1,SXR1,SYR1,PRS1,XB1,YB1,FLT1,
     1TF11,TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1
 204  FORMAT(I5,5X,7F10.2,/8F10.2,/8F10.2)
C
C    NUMBER OF MAIN ROUNDS FIRED PER SAMPLE SPECIFIED.
C
 201  IF(NRDS.LT.10) NRDS=10
      IF(NRDS.GT.19) NRDS=19
      IF(NOPT1.EQ.3) NRDS=1
C
C    WRITE MAIN ROUND INPUT DATA.
C
      WRITE(6,2)NOPT1,NRDS,NOPT
 2    FORMAT(    ////////////21H         SIMULATION = ,I5,/20H NUMBER OF R
     1OUNDS = ,I5,/8H NOPT = ,I5)
      WRITE(6,3)
 3    FORMAT(//28X,24H HORIZONTAL    VERTICAL  ,//31X,7H METERS, 5X,7H ME
     1TERS,/)
      WRITE(6,4)SXS,SYS,SXB,SYB,SXR,SYR,XB,YB,XC,YC,SIGXL,SIGYL
 4    FORMAT(26H SENSING ERRORS (STD DEV) ,2F12.4,/24H VARIABLE BIAS (ST
     1D DEV),2X,2F12.4,/24H RANDOM ERRORS (STD DEV),2X,2F12.4,/11H FIXED
     2 BIAS,15X,2F12.4,/11H AIM CENTER,15X,2F12.4/,10H LAY ERROR,16X,
     32F12.4/)
      WRITE(6,7)PRS,REL,YDEF,RELF
 7    FORMAT(39H PROBABILITY OF SENSING MISSING ROUND =,F12.6,/23H RELIA
     1BILITY OF ROUND = ,F12.6,/30H VERTICAL DEFILADED COORDINATES = ,
```

Figure 7-3. Source Listing, Subroutine INPUT (1 of 3)

```
     2F12.6,7H INCHES/,23H RELIABILITY OF FUZE = ,F28.6)
      WRITE(6,19)FLT,TF1,TFS,XM1,XM2,AMT1,AMT2,ST1,ST2
 19   FORMAT(/////32X,16H TIME DATA(SECS),///18H TIME OF FLIGHT = ,F12.6
     1,///26X,10H 1ST ROUND,9X,16H SUBSEQUENT RDS.,//25H FIXED MEDIAN TI
     2ME       ,F12.6,10X,F12.6,/25H VARIABLE MEDIAN TIME    ,F12.6,10X,
     3F12.6,/25H MINIMUM TIME            ,F12.6,10X,F12.6,/25H SLOPE OF
     4DISTRIBUTION   ,F12.6,10X,F12.6)
C
C    CONVERT MAIN RD. DELIVERY DATA FROM METRIC TO ENGLISH STANDARD UNITS.
C
      SXS=SXS*39.37
      SYS=SYS*39.37
      SXB=SXB*39.37
      SYB=SYB*39.37
      SXR=SXR*39.37
      SYR=SYR*39.37
      SIGXL=SIGXL*39.37
      SIGYL=SIGYL*39.37
      XB =XB *39.37
      YB =YB *39.37
      XC=XC*39.37
      YC=YC*39.37
C
C    CHECK FLAG FOR WRITING SPOTTING RIFLE ROUND DATA.
C
      IF(NOPT1.NE.2)GOTO202
      RELF1=1.
      REL1=1.
      WRITE(6,18)
      WRITE(6,203)
 203  FORMAT(////20H SPOTTING RIFLE DATA,//)
      WRITE(6,3)
      WRITE(6,4)SXS1,SYS1,SXB1,SYB1,SXR1,SYR1,XB1,YB1,XC,YC,SIGXL1,SIGYL
     11
      WRITE(6,7)PRS1,REL1,YDEF,RELF1
      WRITE(6,19)FLT1,TF11,TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21
C
C    CONVERT SPOT RD. DELIVERY DATA FROM METRIC TO ENGLISH STANDARD UNITS.
C
      SXS1=SXS1*39.37
      SYS1=SYS1*39.37
      SXB1=SXB1*39.37
      SYB1=SYB1*39.37
      SXR1=SXR1*39.37
      SYR1=SYR1*39.37
      SIGXL1=SIGXL1 *39.37
      SIGYL1=SIGYL1 *39.37
      XB1=XB1*39.37
      YB1=YB1*39.37
C
C    CREW PROFICIENCY TIME FACTORS SET.
C
      IF(ST11.EQ.0.) ST11=.4983
      IF(ST21.EQ.0.) ST21=.4983
 202  IF(ST1.EQ.0.) ST1=.4983
      IF(ST2.EQ.0.) ST2=.4983

C
 302  IF(X.GT.999.) RETURN
C
C    CONVERT TARGET COORDINATES INTO TO KILL ARRAY SUBSCRIPTS.
```

Figure 7-3. Source Listing, Subroutine INPUT (2 of 3)

```
C
C    CHECK INPUT CONTROL FLAG FOR USING PREVIOUS DATA SET UP.
C
       IF(NOPT.EQ.0)RETURN
C
C    READ TARGET DATA.
C
       READ(5,1)NX,NY
       NX1=NX+1
       NY1=NY+1
 1     FORMAT(3I5,5X,6F10.2,/8F10.2,/8F10.2,/8F10.2)
 15    READ(5,51)XMIN,YMIN,DX,DY
C
C    SET VULNERABILITY CARD LIMIT.
C
       NC=3000
C
C    SET UP VULNERABILITY MATRIX.
C
       AX(1)=XMIN
       DO 16 I=2,NX1
 16    AX(I)=AX(I-1)+DX
       AY(1)=YMIN
       DO 17 I=2,NY1
 17    AY(I)=AY(I-1)+DY
C
C    INITIALIZE TO KILL ARRAY.
C
 56    DO54I=1,NX
       DO54J=1,NY
 54    IK(J,I)=0
C
C    ENTER VULNERABILITY CARD-LOOP.
C
       DO521=1,NC
       NC1=5
       IF(PASSN.LE.0.)NC1=4
C
C    CHECK FLAG FOR STANDARD ARRAY SET UP.
C
       IF(NOPT.EQ.1)GOTO303
C
C    REVERSE TARGET ORIENTATION.
C
       READ(5,304)X,Y,(PK(I,J),J=1,NC1)
       Y=-Y
       GOTO302
 303   READ(5,305)X,Y,(PK(I,J),J=1,NC1)
 304   FORMAT(2F7.2,38X,4F7.1)
 305   FORMAT(2F7.2, 6X,5F7.1)
C
C    CHECK FOR LAST VULNERABILITY CARD.
C
       J1=((X-XMIN)/DX)+1.
       J2=((Y-YMIN)/DY)+1.
 52    IK(J2,J1)=I
 10    FORMAT(1H1)
       RETURN
 51    FORMAT(4F10.1,I5)
 6     CALL EXIT
       END
```

Figure 7-3. Source Listing, Subroutine INPUT (3 of 3)

```
      SUBROUTINE KILRAT
C
C*****************************************************************************
C    PURPOSE
C    COMPUTES AND WRITES THE AVERAGE NUMBER OF MAIN ROUNDS FIRED PER CASE.
C*****************************************************************************
C
      DIMENSION AKIL( 61,9),F( 61),G( 61),SMK(19 ,9),AA( 61),PK(3000,8),
     1AX(201),AY(51)
      COMMON PK,AX,AY,SIGXR,SIGYR,SIGXB, SIGYB,SIGXS,SIGYS,SIG   ,XB,YB,
     1XC,YC,RFL,TF1,TFS,XM1,XM2,YDEF,NOPT1,NR   ,NX,NY,FLT,ST1,ST2,AMT1,
     2AMT2,TK(50,200),SMK,F,AKIL,SIGXL,SIGYL,RELF
     3,SIGXS1,SIGYS1,SIGXB1,SIGYB1,SIGXR1,SIGYR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NRDS1,PASSN
C
C    ENTER CASE LOOP.
C
      DO 2 I1=1,6
      SMIK=SMK(1,I1)
      AUL=2.
      ANR=NR
      J=NR
C
C    ENTER ROUND LOOP AND COMPUTE AVG. RDS. FIRED.
C
      DO25I=2,J
      SMIK=SMIK+(AUL*(SMK(I,I1)-SMK(I-1,I1)))
 25   AUL=AUL+1.
C
C    DID ALL SAMPLES REGISTER A KILL?
C
      IF(SMK(NR,I1).GT..9999) GOTO99
      AR=5.-(SMK(J-5,I1)+SMK(J-4,I1)+SMK(J-3,I1)+SMK(J-2,I1)+SMK(J-1,I1))
     1)
      XX=SMK(J   ,I1)-SMK(J-5,I1)
      IF(XX.LE.0.)GOTO99
      AZ=AR/XX
C
C    COMPUTE AVG RDS FIRED INCLUDING NON-KILLING SAMPLES AND EXTRAPOLATION FACTOR
C
      AV=(AZ+ANR)*(1.-SMK(J   ,I1))+SMIK
      GOTO98
C
C    WRITE AVG ROUNDS FIRED PER CASE.
C
 99   AV=SMIK
 98   WRITE(6,26) AV,I1
 26   FORMAT(16H AVG. NO. RDS = ,F7.2,8H CASE = ,I5,//)
    2 CONTINUE
      RETURN
      END
```

Figure 7-4. Source Listing, Subroutine KILRAT

```
      SUBROUTINE NRAN31(X1,X2)
C
C*****************************************************************************
C    PURPOSE
C    GENERATES RANDOM NORMAL DEVIATES.
C
C    FUNCTION RANDOM REQUIRED.
C*****************************************************************************
C
      X3=SQRT(-2.*ALOG(RANDOM(1)))
      X4=6.283185307Z*RANDOM(1)
      X2=X3*SIN(X4)
      X1=X3*COS(X4)
      RETURN
      END
```

Figure 7-5. Source Listing, Subroutine NRAN31 (X1, X2)

```
      FUNCTION RANDOM(N)
C*****************************************************************************
C    PURPOSE
C    GENERATES UNIFORM RANDOM NUMBERS BETWEEN 0. AND 1.
C*****************************************************************************
C
      COMMON/ RANDM/IX
      IX=IX*65539
      IF(IX)5,6,6
 5    IX=IX+2147483647+1
 6    SUM =IX
 1    SUM=SUM*.4656613E-9
      RANDOM=SUM
      RETURN
      END
```

Figure 7-6. Source Listing, Function RANDOM (N)

```
      SUBROUTINE SSHOT(PCH,PCH1)
C
C*****************************************************************************
C    PURPOSE
C    COMPUTES PH TARGET FOR A SINGLE MAIN ROUND AND FOR A SINGLE MAIN ROUND
C    GIVEN A SENSED MISS BY USING A CLOSED FORM SOLUTION.
C
C    FUNCTION ONE REQUIRED.
C*****************************************************************************
C
      DIMENSION PK(3000 ,8),AX(201),AY(51 ),Z(19,9),Z1(61)
      COMMON PK,AX,AY,SIGXR,SIGYR,SIGXB, SIGYB,SIGXS,SIGYS,PROBS,XB,YB,
     1XC,YC,REL,TF1,TFS,XM1,XM2,YDEF,NOPT1,NROS,NX,NY,FLT,ST1,ST2,AMT1,
     2AMT2,TK(50 ,200),Z,Z1,AKIL(61,9),SIGXL,SIGYL,RELF
     3,SIGXS1,SIGYS1,SIGXB1,SIGYB1,SIGXR1,SIGYR1,PRS1,XB1,YB1,FLT1,TF11,
     4TFS1,XM11,XM21,AMT11,AMT21,ST11,ST21,SIGXL1,SIGYL1,NROS1,PASSN
      PCH =0.
      PCH1=0.
C
C    COMPUTE IMPACT SIGMAS FOR A SINGLE MAIN ROUND.
C
      SIGX=SQRT(SIGXR**2+SIGXB**2+SIGXL**2)
      SIGY=SQRT(SIGYR**2+SIGYB**2+SIGYL**2)
      SIGA=SQRT(SIGXS**2+2.*SIGXR**2)
      SIGB=SQRT(SIGYS**2+2.*SIGYR**2)
C
C    CHECK FOR SPOTTING ROUND DATA.
C
      IF(NOPT1.NE.2)GOTO3
C
C    MODIFY IMPACT SIGMAS.
C
      SIGX=SQRT(SIGX**2+(.5*(SIGXS1+SIGXL1))**2+SIGXR1**2)
      SIGY=SQRT(SIGY**2+(.5*(SIGYS1+SIGYL1))**2+SIGYR1**2)
C
C    ENTER LOOP TO  SELECT CELL VERTICAL COORDINATES.
C
 3    DO2J=1,NY
      Y2=AY(J+1)-YC
      Y1=AY(J  )-YC
C
C    CHECK TARGET DEFILADED CONDITIONS.
C
      IF(AY(J+1).LE.YDEF) GOTO2
      IF(AY(J  ).LT.YDEF) Y1=YDEF-YC
C
C    ENTER LOOP TO SELECT CELL HORIZONTAL COORDINATES.
C
      DO1I=1,NX
C
C    CHECK THAT CELL IN TARGET.
C
      IF(TK(J,I).LE.0 )GOTO1
      X1=AX(I  )-XC
      X2=AX(I+1)-XC
C
```

Figure 7-7. Source Listing, Subroutine SSHOT (PCH, PCH1) (Page 1 of 2)

```
C    COMPUTE AND SUM CELL PH'S.
C
       PA =(CNF((X2-XB)/STGX)-CNF((X1-XB)/STGX))*(CNF((Y2-YB)/STGY)-CNF((
      1Y1-YB)/STGY))
       PA1=(CNF(X2/STGA)-CNF(X1/STGA))*(CNF(Y2/STGB)-CNF(Y1/STGB))
       PCH =PCH +PA
       PCH1=PCH1+PA1
 1     CONTINUE
 2     CONTINUE
       RETURN
       END
```

Figure 7-7. Source Listing, Subroutine SSHOT (PCH, PCH1) (Page 2 of 2)

APPENDIX A

Appendix A contains the entire vulnerability card input deck for the sample case presented in Section VI.

24.0	84.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.0	44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32.0	32.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
28.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-44.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-48.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-52.0	32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
40.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
36.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
32.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
28.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
24.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
20.0	28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
16.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-48.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-52.0	28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
48.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44.0	24.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
40.0	24.0	.987	.998	.998	.798	.987	.998	.998	.798
36.0	24.0	.987	.998	.998	.798	.987	.998	.998	.798
32.0	24.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
28.0	24.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
24.0	24.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
20.0	24.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
16.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.0	24.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
8.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-12.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-16.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-20.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-32.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-36.0	24.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-44.0	24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
48.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44.0	20.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
40.0	20.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
36.0	20.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
32.0	20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
28.0	20.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
24.0	20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
20.0	20.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
16.0	20.0	.987	.998	.998	.798	.987	.998	.998	.798
12.0	20.0	.987	.998	.998	.798	.987	.998	.998	.798
8.0	20.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
4.0	20.0	.987	.998	.998	.798	.987	.998	.998	.798
0.0	20.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798

-4.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	20.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-12.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-16.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-20.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-24.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-28.0	20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-32.0	20.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-36.0	20.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-40.0	20.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-44.0	20.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
52.0	16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
48.0	16.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
44.0	16.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
40.0	16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
36.0	16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
32.0	16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
28.0	16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
24.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
20.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
16.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
12.0	16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8.0	16.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
4.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
0.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
-4.0	16.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-8.0	16.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-12.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
-16.0	16.0	.987	.998	.998	.798	.987	.998	.998	.798
-20.0	16.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-24.0	16.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-28.0	16.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-32.0	16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-36.0	16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-40.0	16.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-44.0	16.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-48.0	16.0	0.000	1.000	1.000	0.000	.987	.998	.998	.798
-52.0	16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-76.0	16.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-80.0	16.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
52.0	12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
48.0	12.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
44.0	12.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
40.0	12.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
36.0	12.0	.987	.998	.998	.798	.987	.998	.998	.798
32.0	12.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
28.0	12.0	.987	.998	.998	.798	.987	.998	.998	.798
24.0	12.0	.987	.998	.998	.798	.987	.998	.998	.798
20.0	12.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
16.0	12.0	.987	.998	.998	.798	.987	.998	.998	.798
12.0	12.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
8.0	12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4.0	12.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
0.0	12.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-4.0	12.0	.987	.998	.998	.798	.987	.998	.998	.798
-8.0	12.0	.987	.998	.998	.798	.987	.998	.998	.798
-12.0	12.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-16.0	12.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-20.0	12.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-24.0	12.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-28.0	12.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-32.0	12.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-36.0	12.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000

-40.0	12.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
-44.0	12.0	0.000	1.000	1.000	0.000	.987	1.000	1.000	.798
-48.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-52.0	12.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
-56.0	12.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
-60.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-64.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-68.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-72.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-76.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-80.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-84.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-88.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-92.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-96.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-100.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-104.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-108.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-112.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-116.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-120.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-124.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-128.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-132.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-136.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-140.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-144.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-148.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-152.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-156.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-164.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-168.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-172.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-176.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-180.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-184.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-188.0	12.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
56.0	8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
52.0	8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
48.0	8.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
44.0	8.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
40.0	8.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
36.0	8.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
32.0	8.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
28.0	8.0	.987	.998	.998	.798	.987	.998	.998	.798
24.0	8.0	.987	.998	.998	.798	.987	.998	.998	.798
20.0	8.0	.987	.998	.998	.798	.987	.998	.998	.798
16.0	8.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12.0	8.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
8.0	8.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
4.0	8.0	.987	.998	.998	.798	.987	.998	.998	.798
0.0	8.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-4.0	8.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-8.0	8.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-12.0	8.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-16.0	8.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
-20.0	8.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
-24.0	8.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-28.0	8.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-32.0	8.0	.987	.998	.998	.798	.987	.998	.998	.798
-36.0	8.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-40.0	8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-44.0	8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

-48.0	8.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
-52.0	8.0	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000
-56.0	8.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
-60.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-64.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-68.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-72.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-76.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-80.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-84.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-88.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-100.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-108.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-112.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-120.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-128.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-136.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-140.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-148.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-168.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-172.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-176.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-180.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-184.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-188.0	8.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
64.0	4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
52.0	4.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
48.0	4.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
44.0	4.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
40.0	4.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
36.0	4.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
32.0	4.0	.987	1.000	1.000	.798	1.000	1.000	1.000	1.000
28.0	4.0	0.000	1.000	1.000	0.000	.987	1.000	1.000	.798
24.0	4.0	.987	.998	.998	.798	.987	.998	.998	.798
20.0	4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
16.0	4.0	0.000	1.000	1.000	0.000	1.000	1.000	1.000	1.000
12.0	4.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
8.0	4.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
4.0	4.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
0.0	4.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-4.0	4.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
-8.0	4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-12.0	4.0	.987	1.000	1.000	.798	0.000	1.000	1.000	0.000
-16.0	4.0	.987	1.000	1.000	.798	1.000	1.000	1.000	1.000
-20.0	4.0	.987	1.000	1.000	.798	.987	1.000	1.000	.798
-24.0	4.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-28.0	4.0	0.000	1.000	1.000	0.000	0.000	1.000	1.000	0.000
-32.0	4.0	.987	1.000	1.000	.798	.987	.998	.998	.798
-36.0	4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-40.0	4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-44.0	4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-48.0	4.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
-52.0	4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-56.0	4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
116.0	0.0	.182	0.000	.182	0.000	.895	0.000	.895	0.000
112.0	0.0	.681	0.000	.681	0.000	.809	0.000	.809	0.000
108.0	0.0	.697	0.000	.697	0.000	.809	0.000	.809	0.000
104.0	0.0	0.000	0.000	0.000	0.000	.755	0.000	.755	0.000
100.0	0.0	.697	0.000	.697	0.000	.809	0.000	.809	0.000
96.0	0.0	.850	0.000	.850	0.000	.895	0.000	.895	0.000
92.0	0.0	.853	0.000	.853	0.000	0.000	0.000	0.000	0.000
88.0	0.0	.636	0.000	.636	0.000	.895	0.000	.895	0.000

84.0	0.0	0.000	0.000	0.000	0.000	.809	0.000	.809	0.000
80.0	0.0	.803	0.000	.803	0.000	.910	0.000	.910	0.000
76.0	0.0	.895	0.000	.895	0.000	0.000	0.000	0.000	0.000
72.0	0.0	.895	0.000	.895	0.000	.849	0.000	.849	0.000
68.0	0.0	.787	0.000	.787	0.000	0.000	0.000	0.000	0.000
64.0	0.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
60.0	0.0	0.000	0.000	0.000	0.000	.910	0.000	.910	0.000
56.0	0.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
52.0	0.0	0.000	0.000	0.000	0.000	.910	0.000	.910	0.000
48.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.0	0.0	0.000	0.000	0.000	0.000	.306	0.000	.306	0.000
36.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32.0	0.0	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000
28.0	0.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
24.0	0.0	.987	1.000	1.000	.798	.306	0.000	.306	0.000
20.0	0.0	.987	1.000	1.000	.798	0.000	1.000	1.000	0.000
16.0	0.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
12.0	0.0	.987	.998	.998	.798	.987	.998	.998	.798
8.0	0.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
4.0	0.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
0.0	0.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-4.0	0.0	.987	1.000	1.000	.798	0.000	0.000	0.000	0.000
-8.0	0.0	.987	.998	.998	.798	.987	.998	.998	.798
-12.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-16.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-20.0	0.0	.987	1.000	1.000	.798	0.000	1.000	1.000	0.000
-24.0	0.0	.987	1.000	1.000	.798	0.000	1.000	1.000	0.000
-28.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-32.0	0.0	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000
-36.0	0.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-40.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-44.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-48.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-52.0	0.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-64.0	0.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-68.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-72.0	0.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-76.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-80.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
140.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
128.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
124.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
116.0	-4.0	0.000	0.000	0.000	0.000	.808	0.000	.808	0.000
112.0	-4.0	.677	0.000	.677	0.000	0.000	0.000	0.000	0.000
108.0	-4.0	.697	0.000	.697	0.000	0.000	0.000	0.000	0.000
104.0	-4.0	.697	0.000	.697	0.000	0.000	0.000	0.000	0.000
100.0	-4.0	.697	0.000	.697	0.000	0.000	0.000	0.000	0.000
96.0	-4.0	.697	0.000	.697	0.000	.808	0.000	.808	0.000
92.0	-4.0	0.000	0.000	0.000	0.000	.808	0.000	.808	0.000
88.0	-4.0	0.000	0.000	0.000	0.000	.808	0.000	.808	0.000
84.0	-4.0	0.000	0.000	0.000	0.000	.808	0.000	.808	0.000
80.0	-4.0	.806	0.000	.806	0.000	.925	0.000	.925	0.000
76.0	-4.0	.807	0.000	.807	0.000	0.000	0.000	0.000	0.000
72.0	-4.0	.807	0.000	.807	0.000	.810	0.000	.810	0.000
68.0	-4.0	0.000	0.000	0.000	0.000	.640	0.000	.640	0.000
64.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
60.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
56.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000

52.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
48.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
44.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
40.0	-4.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
36.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28.0	-4.0	0.000	0.000	0.000	0.000	.996	.998	.999	.798
24.0	-4.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
20.0	-4.0	.989	.998	.998	.798	.996	.998	.999	.798
16.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
12.0	-4.0	.987	.998	.998	.798	.987	.998	.998	.798
8.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
4.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
0.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-4.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-8.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-12.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-16.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-20.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-24.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-28.0	-4.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-32.0	-4.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-36.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-40.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-44.0	-4.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-48.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-52.0	-4.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-56.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-60.0	-4.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-64.0	-4.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-68.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-72.0	-4.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-76.0	-4.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-80.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-84.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-88.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-92.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-96.0	-4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
128.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
124.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.0	-8.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
116.0	-8.0	.667	0.000	.667	0.000	0.000	0.000	0.000	0.000
112.0	-8.0	.677	0.000	.677	0.000	0.000	0.000	0.000	0.000
108.0	-8.0	.697	0.000	.697	0.000	0.000	0.000	0.000	0.000
104.0	-8.0	.697	0.000	.697	0.000	0.000	0.000	0.000	0.000
100.0	-8.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
96.0	-8.0	.697	0.000	.697	0.000	0.000	0.000	0.000	0.000
92.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.0	-8.0	0.000	0.000	0.000	0.000	.768	0.000	.768	0.000
84.0	-8.0	.782	0.000	.782	0.000	.791	0.000	.791	0.000
80.0	-8.0	.803	0.000	.803	0.000	.810	0.000	.810	0.000
76.0	-8.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
72.0	-8.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
68.0	-8.0	.742	0.000	.742	0.000	.640	0.000	.640	0.000
64.0	-8.0	.742	0.000	.742	0.000	.640	0.000	.640	0.000
60.0	-8.0	0.000	0.000	0.000	0.000	.640	0.000	.640	0.000
56.0	-8.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
52.0	-8.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
48.0	-8.0	0.000	0.000	0.000	0.000	.649	0.000	.649	0.000
44.0	-8.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000
40.0	-8.0	0.000	0.000	0.000	0.000	.660	0.000	.660	0.000

36.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.0	-8.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
20.0	-8.0	.994	.998	.999	.818	.996	.998	.999	.818
16.0	-8.0	.988	.998	.998	.818	.988	.998	.998	.818
12.0	-8.0	.988	.998	.998	.818	.988	.998	.998	.818
8.0	-8.0	.988	.998	.998	.818	.988	.998	.998	.818
4.0	-8.0	.987	.998	.998	.798	.988	.998	.998	.818
0.0	-8.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-4.0	-8.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-8.0	-8.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-12.0	-8.0	.987	.998	.998	.798	.987	.998	.998	.798
-16.0	-8.0	.987	.998	.998	.798	.987	.998	.998	.798
-20.0	-8.0	.987	.998	.998	.798	.987	.998	.998	.798
-24.0	-8.0	.987	.998	.998	.798	.987	.998	.998	.798
-28.0	-8.0	.988	.998	.998	.818	0.000	0.000	0.000	0.000
-32.0	-8.0	.988	.998	.998	.818	0.000	0.000	0.000	0.000
-36.0	-8.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-40.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-44.0	-8.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-48.0	-8.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-52.0	-8.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-56.0	-8.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-60.0	-8.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-64.0	-8.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-68.0	-8.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-72.0	-8.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-76.0	-8.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-80.0	-8.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-84.0	-8.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-88.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-92.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-96.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-104.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-112.0	-8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
128.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
124.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
116.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
112.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
108.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
104.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
100.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
96.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
92.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
88.0	-12.0	.810	0.000	.810	0.000	.813	0.000	.813	0.000
84.0	-12.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
80.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
76.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
72.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
68.0	-12.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
64.0	-12.0	.810	0.000	.810	0.000	.803	0.000	.803	0.000
60.0	-12.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
56.0	-12.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
52.0	-12.0	.997	.998	.999	.798	.810	0.000	.810	0.000
48.0	-12.0	.987	.998	.998	.798	.810	0.000	.810	0.000
44.0	-12.0	1.000	1.000	1.000	1.000	.810	0.000	.810	0.000
40.0	-12.0	.987	.998	.998	.798	.810	0.000	.810	0.000
36.0	-12.0	1.000	1.000	1.000	1.000	.810	0.000	.810	0.000
32.0	-12.0	1.000	1.000	1.000	1.000	.810	0.000	.810	0.000

28.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
24.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
20.0	-12.0	.997	.998	.999	.818	.998	.998	1.000	.818
16.0	-12.0	.988	.998	.998	.818	.988	.998	.998	.818
12.0	-12.0	.988	.998	.998	.818	.988	.998	.998	.818
8.0	-12.0	.988	.998	.998	.818	.988	.998	.998	.818
4.0	-12.0	.988	.998	.998	.818	.988	.998	.998	.818
0.0	-12.0	.988	.998	.998	.818	.988	.998	.998	.818
-4.0	-12.0	.987	.998	.998	.798	.987	.998	.998	.798
-8.0	-12.0	.987	.998	.998	.798	.987	.998	.998	.798
-12.0	-12.0	.987	.998	.998	.798	.987	.998	.998	.798
-16.0	-12.0	.987	.998	.998	.798	.987	.998	.998	.798
-20.0	-12.0	.987	.998	.998	.798	.987	.998	.998	.798
-24.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-28.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-32.0	-12.0	.988	.998	.998	.818	.988	.998	.998	.818
-36.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-40.0	-12.0	1.000	1.000	1.000	1.000	.988	.998	.998	.818
-44.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-48.0	-12.0	1.000	1.000	1.000	1.000	.988	.998	.998	.818
-52.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-56.0	-12.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-60.0	-12.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-64.0	-12.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-68.0	-12.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-72.0	-12.0	0.000	0.000	0.000	0.000	.989	.998	.998	.836
-76.0	-12.0	0.000	0.000	0.000	0.000	.989	.998	.998	.836
-80.0	-12.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-84.0	-12.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-88.0	-12.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-92.0	-12.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-96.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-100.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-104.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-120.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-124.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-128.0	-12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132.0	-16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
128.0	-16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
124.0	-16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.0	-16.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
116.0	-16.0	1.000	0.000	1.000	0.000	.794	0.000	.794	0.000
112.0	-16.0	1.000	0.000	1.000	0.000	.794	0.000	.794	0.000
108.0	-16.0	.884	0.000	.884	0.000	.794	0.000	.794	0.000
104.0	-16.0	.810	0.000	.810	0.000	.793	0.000	.793	0.000
100.0	-16.0	.810	0.000	.810	0.000	.794	0.000	.794	0.000
96.0	-16.0	.810	0.000	.810	0.000	.793	0.000	.793	0.000
92.0	-16.0	.810	0.000	.810	0.000	0.000	0.000	0.000	0.000
88.0	-16.0	.810	0.000	.810	0.000	.794	0.000	.794	0.000
84.0	-16.0	.810	0.000	.810	0.000	.794	0.000	.794	0.000
80.0	-16.0	.810	0.000	.810	0.000	.791	0.000	.791	0.000
76.0	-16.0	.810	0.000	.810	0.000	1.000	0.000	1.000	0.000
72.0	-16.0	.810	0.000	.810	0.000	1.000	0.000	1.000	0.000
68.0	-16.0	.810	0.000	.810	0.000	1.000	0.000	1.000	0.000
64.0	-16.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
60.0	-16.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
56.0	-16.0	.810	0.000	.810	0.000	.810	0.000	.810	0.000
52.0	-16.0	.997	.998	.999	.798	.810	0.000	.810	0.000
48.0	-16.0	.997	.998	.999	.798	.884	0.000	.884	0.000
44.0	-16.0	.997	.998	.999	.798	.884	0.000	.884	0.000
40.0	-16.0	1.000	1.000	1.000	1.000	.810	0.000	.810	0.000
36.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

32.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
28.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
24.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
20.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
16.0	-16.0	.988	.998	.998	.818	.988	.998	.998	.818
12.0	-16.0	.988	.998	.998	.818	.988	.998	.998	.818
8.0	-16.0	.988	.998	.998	.818	.988	.998	.998	.818
4.0	-16.0	.988	.998	.998	.818	.988	.998	.998	.818
0.0	-16.0	.988	.998	.998	.818	.988	.998	.998	.818
-4.0	-16.0	.987	.998	.998	.798	.987	.998	.998	.798
-8.0	-16.0	.987	.998	.998	.798	.987	.998	.998	.798
-12.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-16.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-20.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-24.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-28.0	-16.0	.987	.998	.998	.798	.987	.998	.998	.798
-32.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-36.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-40.0	-16.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-44.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-48.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-52.0	-16.0	1.000	0.000	1.000	0.000	1.000	1.000	1.000	1.000
-56.0	-16.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-60.0	-16.0	1.000	0.000	1.000	0.000	1.000	1.000	1.000	1.000
-64.0	-16.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-68.0	-16.0	.884	0.000	.884	0.000	.988	.998	.998	.818
-72.0	-16.0	.884	0.000	.884	0.000	.988	.998	.998	.818
-76.0	-16.0	0.000	0.000	0.000	0.000	.989	.998	.998	.836
-80.0	-16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-84.0	-16.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-88.0	-16.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-92.0	-16.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-96.0	-16.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-100.0	-16.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-108.0	-16.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-112.0	-16.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-116.0	-16.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-120.0	-16.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-124.0	-16.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
136.0	-20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132.0	-20.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
128.0	-20.0	.945	0.000	.945	0.000	.945	0.000	.945	0.000
124.0	-20.0	.945	0.000	.945	0.000	.884	0.000	.884	0.000
120.0	-20.0	.945	0.000	.945	0.000	0.000	0.000	0.000	0.000
116.0	-20.0	.772	0.000	.772	0.000	0.000	0.000	0.000	0.000
112.0	-20.0	.981	0.000	.981	0.000	.794	0.000	.794	0.000
108.0	-20.0	1.000	0.000	1.000	0.000	.794	0.000	.794	0.000
104.0	-20.0	1.000	0.000	1.000	0.000	.794	0.000	.794	0.000
100.0	-20.0	.884	0.000	.884	0.000	.794	0.000	.794	0.000
96.0	-20.0	1.000	0.000	1.000	0.000	.794	0.000	.794	0.000
92.0	-20.0	1.000	0.000	1.000	0.000	.794	0.000	.794	0.000
88.0	-20.0	.810	0.000	.810	0.000	.794	0.000	.794	0.000
84.0	-20.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
80.0	-20.0	.810	0.000	.810	0.000	1.000	0.000	1.000	0.000
76.0	-20.0	1.000	0.000	1.000	0.000	.997	0.000	.997	0.000
72.0	-20.0	.810	0.000	.810	0.000	.884	0.000	.884	0.000
68.0	-20.0	1.000	0.000	1.000	0.000	.945	0.000	.945	0.000
64.0	-20.0	.810	0.000	.810	0.000	.884	0.000	.884	0.000
60.0	-20.0	.810	0.000	.810	0.000	.523	0.000	.523	0.000
56.0	-20.0	0.000	0.000	0.000	0.000	.523	0.000	.523	0.000
52.0	-20.0	.997	.998	.999	.798	1.000	0.000	1.000	0.000
48.0	-20.0	.997	.998	.999	.798	.884	0.000	.884	0.000
44.0	-20.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000

40.0	-20.0	1.000	1.000	1.000	1.000	.884	0.000	.884	0.000
36.0	-20.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
32.0	-20.0	1.000	1.000	1.000	1.000	.884	0.000	.884	0.000
28.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
24.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
20.0	-20.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
16.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-4.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-8.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-12.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-16.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-20.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-24.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-28.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-32.0	-20.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-36.0	-20.0	1.000	0.000	1.000	0.000	1.000	1.000	1.000	1.000
-40.0	-20.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
-44.0	-20.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
-48.0	-20.0	.884	0.000	.884	0.000	1.000	1.000	1.000	1.000
-52.0	-20.0	.884	0.000	.884	0.000	1.000	1.000	1.000	1.000
-56.0	-20.0	.884	0.000	.884	0.000	1.000	1.000	1.000	1.000
-60.0	-20.0	.269	0.000	.269	0.000	1.000	1.000	1.000	1.000
-64.0	-20.0	.465	0.000	.465	0.000	1.000	1.000	1.000	1.000
-68.0	-20.0	.955	0.000	.955	0.000	1.000	0.000	1.000	0.000
-72.0	-20.0	.915	0.000	.915	0.000	.988	.998	.998	.818
-76.0	-20.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
-80.0	-20.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-84.0	-20.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-88.0	-20.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-92.0	-20.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
-96.0	-20.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-100.0	-20.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-104.0	-20.0	0.000	0.000	0.000	0.000	.342	.100	.342	.100
-108.0	-20.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
-112.0	-20.0	0.000	0.000	0.000	0.000	.465	0.000	.465	0.000
-116.0	-20.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-120.0	-20.0	.915	0.000	.915	0.000	.269	0.000	.269	0.000
-124.0	-20.0	.915	0.000	.915	0.000	.915	0.000	.915	0.000
-128.0	-20.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
136.0	-24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132.0	-24.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
128.0	-24.0	.945	0.000	.945	0.000	.945	0.000	.945	0.000
124.0	-24.0	.998	0.000	.998	0.000	.945	0.000	.945	0.000
120.0	-24.0	1.000	0.000	1.000	0.000	.998	0.000	.998	0.000
116.0	-24.0	.981	0.000	.981	0.000	.981	0.000	.981	0.000
112.0	-24.0	.999	0.000	.999	0.000	.563	0.000	.563	0.000
108.0	-24.0	.981	0.000	.981	0.000	.796	0.000	.796	0.000
104.0	-24.0	.523	0.000	.523	0.000	.796	0.000	.796	0.000
100.0	-24.0	0.000	0.000	0.000	0.000	.796	0.000	.796	0.000
96.0	-24.0	0.000	0.000	0.000	0.000	.795	0.000	.795	0.000
92.0	-24.0	0.000	0.000	0.000	0.000	.795	0.000	.795	0.000
88.0	-24.0	0.000	0.000	0.000	0.000	.780	0.000	.780	0.000
84.0	-24.0	.681	0.000	.681	0.000	.781	0.000	.781	0.000
80.0	-24.0	1.000	0.000	1.000	0.000	.754	0.000	.754	0.000
76.0	-24.0	.810	0.000	.810	0.000	.998	0.000	.998	0.000
72.0	-24.0	1.000	0.000	1.000	0.000	.998	0.000	.998	0.000
68.0	-24.0	0.000	0.000	0.000	0.000	.998	0.000	.998	0.000
64.0	-24.0	.468	0.000	.468	0.000	.999	0.000	.999	0.000
60.0	-24.0	0.000	0.000	0.000	0.000	.981	0.000	.981	0.000
56.0	-24.0	0.000	0.000	0.000	0.000	.523	0.000	.523	0.000

56.0	-24.0	0.000	0.000	0.000	0.000	.523	0.000	.523	0.000
52.0	-24.0	.992	.998	.999	.798	.810	0.000	.810	0.000
48.0	-24.0	.990	.998	.998	.798	.681	0.000	.681	0.000
44.0	-24.0	1.000	0.000	1.000	0.000	.810	0.000	.810	0.000
40.0	-24.0	0.000	0.000	0.000	0.000	.468	0.000	.468	0.000
36.0	-24.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
32.0	-24.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
28.0	-24.0	0.000	0.000	0.000	0.000	.810	0.000	.810	0.000
24.0	-24.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
20.0	-24.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
16.0	-24.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12.0	-24.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
8.0	-24.0	.988	.998	.998	.818	.988	.998	.998	.818
4.0	-24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	-24.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-4.0	-24.0	.987	.998	.998	.798	1.000	1.000	1.000	1.000
-8.0	-24.0	.987	.998	.998	.798	.987	.998	.998	.798
-12.0	-24.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-16.0	-24.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-20.0	-24.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-24.0	-24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-28.0	-24.0	.988	.998	.998	.818	.988	.998	.998	.818
-32.0	-24.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
-36.0	-24.0	.137	0.000	.137	0.000	1.000	1.000	1.000	1.000
-40.0	-24.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
-44.0	-24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-48.0	-24.0	.987	.998	.998	.798	1.000	0.000	1.000	0.000
-52.0	-24.0	.269	0.000	.269	0.000	0.000	0.000	0.000	0.000
-56.0	-24.0	.465	0.000	.465	0.000	0.000	0.000	0.000	0.000
-60.0	-24.0	.994	.998	.999	.818	1.000	0.000	1.000	0.000
-64.0	-24.0	1.000	0.000	1.000	0.000	1.000	1.000	1.000	1.000
-68.0	-24.0	1.000	0.000	1.000	0.000	.991	.998	.998	.818
-72.0	-24.0	.938	0.000	.938	0.000	.989	.998	.998	.836
-76.0	-24.0	.884	0.000	.884	0.000	.989	.998	.998	.836
-80.0	-24.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-84.0	-24.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-88.0	-24.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-92.0	-24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-96.0	-24.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-100.0	-24.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
-104.0	-24.0	0.000	0.000	0.000	0.000	.519	.100	.519	.100
-108.0	-24.0	0.000	0.000	0.000	0.000	.609	0.000	.609	0.000
-112.0	-24.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-116.0	-24.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-120.0	-24.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-124.0	-24.0	.915	0.000	.915	0.000	.915	0.000	.915	0.000
-128.0	-24.0	.915	0.000	.915	0.000	.915	0.000	.915	0.000
140.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132.0	-28.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
128.0	-28.0	.945	0.000	.945	0.000	.945	0.000	.945	0.000
124.0	-28.0	.998	0.000	.998	0.000	.998	0.000	.998	0.000
120.0	-28.0	.998	0.000	.998	0.000	.981	0.000	.981	0.000
116.0	-28.0	.981	0.000	.981	0.000	0.000	0.000	0.000	0.000
112.0	-28.0	.981	0.000	.981	0.000	.992	0.000	.992	0.000
108.0	-28.0	.523	0.000	.523	0.000	.992	0.000	.992	0.000
104.0	-28.0	.550	0.000	.550	0.000	.797	0.000	.797	0.000
100.0	-28.0	.057	0.000	.057	0.000	.797	0.000	.797	0.000
96.0	-28.0	.057	0.000	.057	0.000	.796	0.000	.796	0.000
92.0	-28.0	.057	0.000	.057	0.000	.546	0.000	.546	0.000
88.0	-28.0	.057	0.000	.057	0.000	.782	0.000	.782	0.000
84.0	-28.0	.057	0.000	.057	0.000	.405	0.000	.405	0.000
80.0	-28.0	.689	0.000	.689	0.000	1.000	0.000	1.000	0.000

76.0	-28.0	0.000	0.000	0.000	0.000	.998	0.000	.998	0.000
72.0	-28.0	.611	0.000	.611	0.000	.998	0.000	.998	0.000
68.0	-28.0	0.000	0.000	0.000	0.000	.999	0.000	.999	0.000
64.0	-28.0	0.000	0.000	0.000	0.000	.998	0.000	.998	0.000
60.0	-28.0	0.000	0.000	0.000	0.000	.960	0.000	.960	0.000
56.0	-28.0	.987	.998	.998	.798	.960	0.000	.960	0.000
52.0	-28.0	.992	.998	.998	.798	.523	0.000	.523	0.000
48.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44.0	-28.0	1.000	1.000	1.000	1.000	.057	0.000	.057	0.000
40.0	-28.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
36.0	-28.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
32.0	-28.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
28.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.0	-28.0	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
20.0	-28.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
16.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.0	-28.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
8.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	-28.0	0.000	0.000	0.000	0.000	.988	.998	.998	.818
0.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	-28.0	0.000	0.000	0.000	0.000	.987	.998	.998	.798
-8.0	-28.0	.987	.998	.998	.798	.987	.998	.998	.798
-12.0	-28.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-16.0	-28.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-20.0	-28.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-24.0	-28.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-28.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-32.0	-28.0	.137	0.000	.137	0.000	.988	.998	.998	.818
-36.0	-28.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-40.0	-28.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-44.0	-28.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-48.0	-28.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-52.0	-28.0	.269	0.000	.269	0.000	0.000	0.000	0.000	0.000
-56.0	-28.0	.994	.998	.999	.818	0.000	0.000	0.000	0.000
-60.0	-28.0	1.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
-64.0	-28.0	1.000	0.000	1.000	0.000	1.000	1.000	1.000	1.000
-68.0	-28.0	1.000	0.000	1.000	0.000	.989	.998	.998	.836
-72.0	-28.0	.915	0.000	.915	0.000	.988	.998	.998	.818
-76.0	-28.0	.915	0.000	.915	0.000	0.000	0.000	0.000	0.000
-80.0	-28.0	.884	0.000	.884	0.000	.137	0.000	.137	0.000
-84.0	-28.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-88.0	-28.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-92.0	-28.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-96.0	-28.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-100.0	-28.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-104.0	-28.0	0.000	0.000	0.000	0.000	.269	0.000	.269	0.000
-108.0	-28.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
-112.0	-28.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-116.0	-28.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-120.0	-28.0	.915	0.000	.915	0.000	.915	0.000	.915	0.000
-124.0	-28.0	.915	0.000	.915	0.000	.915	0.000	.915	0.000
-128.0	-28.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-132.0	-28.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
132.0	-32.0	.945	0.000	.945	0.000	.945	0.000	.945	0.000
128.0	-32.0	.945	0.000	.945	0.000	.945	0,000	.945	0.000
124.0	-32.0	.995	0.000	.995	0.000	.995	0.000	.995	0.000
120.0	-32.0	.991	0.000	.991	0.000	.981	0.000	.981	0.000
116.0	-32.0	.981	0.000	.981	0.000	0.000	0.000	0.000	0.000
112.0	-32.0	.550	0.000	.550	0.000	0.000	0.000	0.000	0.000
108.0	-32.0	.057	0.000	.057	0.000	0.000	0.000	0.000	0.000
104.0	-32.0								

100.0	-32.0	.197	0.000	.197	0.000	0.000	0.000	0.000	0.000
96.0	-32.0	.197	0.000	.197	0.000	.361	0.000	.361	0.000
92.0	-32.0	.057	0.000	.057	0.000	0.000	0.000	0.000	0.000
88.0	-32.0	.057	0.000	.057	0.000	.797	0.000	.797	0.000
84.0	-32.0	.057	0.000	.057	0.000	.452	0.000	.452	0.000
80.0	-32.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
76.0	-32.0	.149	0.000	.149	0.000	.998	0.000	.998	0.000
72.0	-32.0	0.000	0.000	0.000	0.000	.998	0.000	.998	0.000
68.0	-32.0	.637	0.000	.637	0.000	.998	0.000	.998	0.000
64.0	-32.0	.149	0.000	.149	0.000	.960	0.000	.960	0.000
60.0	-32.0	0.000	0.000	0.000	0.000	.998	0.000	.998	0.000
56.0	-32.0	.993	.998	.999	.798	.594	0.000	.594	0.000
52.0	-32.0	0.000	0.000	0.000	0.000	.699	0.000	.699	0.000
48.0	-32.0	.987	.998	.998	.798	.716	0.000	.716	0.000
44.0	-32.0	.987	.998	.998	.798	.057	0.000	.057	0.000
40.0	-32.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
28.0	-32.0	1.000	1.000	1.000	1.000	.057	0.000	.057	0.000
32.0	-32.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
36.0	-32.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
24.0	-32.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
20.0	-32.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
16.0	-32.0	.987	.998	.998	.798	.988	.998	.998	.818
12.0	-32.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8.0	-32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	-32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	-32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	-32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	-32.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-12.0	-32.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-16.0	-32.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-20.0	-32.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-24.0	-32.0	.137	0.000	.137	0.000	1.000	1.000	1.000	1.000
-28.0	-32.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-32.0	-32.0	.137	0.000	.137	0.000	1.000	1.000	1.000	1.000
-36.0	-32.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-40.0	-32.0	.137	0.000	.137	0.000	.988	.998	.998	.818
-44.0	-32.0	.137	0.000	.137	0.000	.988	.998	.998	.818
-48.0	-32.0	.989	.998	.998	.798	0.000	0.000	0.000	0.000
-52.0	-32.0	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
-56.0	-32.0	.990	.998	.998	.798	0.000	0.000	0.000	0.000
-60.0	-32.0	.994	.998	.999	.818	0.000	0.000	0.000	0.000
-64.0	-32.0	1.000	0.000	1.000	0.000	.988	.998	.998	.818
-68.0	-32.0	.938	0.000	.938	0.000	.989	.998	.998	.836
-72.0	-32.0	.915	0.000	.915	0.000	0.000	0.000	0.000	0.000
-76.0	-32.0	.884	0.000	.884	0.000	.137	0.000	.137	0.000
-80.0	-32.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-84.0	-32.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-88.0	-32.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-92.0	-32.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-96.0	-32.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-100.0	-32.0	0.000	0.000	0.000	0.000	.269	0.000	.269	0.000
-104.0	-32.0	0.000	0.000	0.000	0.000	.269	0.000	.269	0.000
-108.0	-32.0	0.000	0.000	0.000	0.000	.465	0.000	.465	0.000
-112.0	-32.0	.465	0.000	.465	0.000	1.000	0.000	1.000	0.000
-116.0	-32.0	1.000	0.000	1.000	0.000	.938	0.000	.938	0.000
-120.0	-32.0	.938	0.000	.938	0.000	.269	0.000	.269	0.000
-124.0	-32.0	.915	0.000	.915	0.000	.884	0.000	.884	0.000
-128.0	-32.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
128.0	-36.0	.945	0.000	.945	0.000	.945	0.000	.945	0.000
124.0	-36.0	.945	0.000	.945	0.000	.884	0.000	.884	0.000
120.0	-36.0	.945	0.000	.945	0.000	.981	0.000	.981	0.000
116.0	-36.0	.523	0.000	.523	0.000	.981	0.000	.981	0.000
112.0	-36.0	.981	0.000	.981	0.000				

108.0	-36.0	.550	0.000	.550	0.000	.981	0.000	.981	0.000
104.0	-36.0	.962	0.000	.962	0.000	.962	0.000	.962	0.000
100.0	-36.0	.057	0.000	.057	0.000	0.000	0.000	0.000	0.000
96.0	-36.0	.245	0.000	.245	0.000	0.000	0.000	0.000	0.000
92.0	-36.0	.200	0.000	.200	0.000	0.000	0.000	0.000	0.000
88.0	-36.0	.197	0.000	.197	0.000	0.000	0.000	0.000	0.000
84.0	-36.0	.197	0.000	.197	0.000	0.000	0.000	0.000	0.000
80.0	-36.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
76.0	-36.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
64.0	-36.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
68.0	-36.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
72.0	-36.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
60.0	-36.0	0.000	0.000	0.000	0.000	.594	0.000	.594	0.000
56.0	-36.0	0.000	0.000	0.000	0.000	.523	0.000	.523	0.000
52.0	-36.0	0.000	0.000	0.000	0.000	.200	0.000	.200	0.000
48.0	-36.0	.993	.998	.999	.798	.057	0.000	.057	0.000
44.0	-36.0	1.000	1.000	1.000	1.000	.197	0.000	.197	0.000
40.0	-36.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
36.0	-36.0	0.000	0.000	0.000	0.000	.200	0.000	.200	0.000
32.0	-36.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
28.0	-36.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
24.0	-36.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
20.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.0	-36.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
12.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	-36.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-16.0	-36.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-12.0	-36.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
-20.0	-36.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-24.0	-36.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-28.0	-36.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-32.0	-36.0	.500	0.000	.500	0.000	0.000	0.000	0.000	0.000
-36.0	-36.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-40.0	-36.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-44.0	-36.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-44.0	-36.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-48.0	-36.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-48.0	-36.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-52.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-56.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-60.0	-36.0	.990	.998	.998	.798	0.000	0.000	0.000	0.000
-64.0	-36.0	1.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
-68.0	-36.0	.884	0.000	.884	0.000	.987	.998	.998	.798
-72.0	-36.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
-76.0	-36.0	.884	0.000	.884	0.000	.137	0.000	.137	0.000
-80.0	-36.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-84.0	-36.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-88.0	-36.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-92.0	-36.0	0.000	0.000	0.000	0.000	.500	0.000	.500	0.000
-96.0	-36.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-100.0	-36.0	0.000	0.000	0.000	0.000	.990	.998	.998	.818
-104.0	-36.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-108.0	-36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-112.0	-36.0	.465	0.000	.465	0.000	.269	0.000	.269	0.000
-116.0	-36.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-120.0	-36.0	.915	0.000	.915	0.000	.269	0.000	.269	0.000
-124.0	-36.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-128.0	-36.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
124.0	-40.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000

120.0	-40.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
116.0	-40.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
112.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
108.0	-40.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
104.0	-40.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
100.0	-40.0	.245	0.000	.245	0.000	.200	0.000	.200	0.000
96.0	-40.0	.360	0.000	.360	0.000	0.000	0.000	0.000	0.000
92.0	-40.0	.245	0.000	.245	0.000	.200	0.000	.200	0.000
88.0	-40.0	.245	0.000	.245	0.000	0.000	0.000	0.000	0.000
84.0	-40.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
80.0	-40.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
76.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72.0	-40.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
68.0	-40.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
64.0	-40.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
60.0	-40.0	0.000	0.000	0.000	0.000	.935	0.000	.935	0.000
56.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
52.0	-40.0	0.000	0.000	0.000	0.000	.245	0.000	.245	0.000
48.0	-40.0	0.000	0.000	0.000	0.000	.245	0.000	.245	0.000
44.0	-40.0	0.000	0.000	0.000	0.000	.245	0.000	.245	0.000
40.0	-40.0	0.000	0.000	0.000	0.000	.245	0.000	.245	0.000
36.0	-40.0	0.000	0.000	0.000	0.000	.200	0.000	.200	0.000
32.0	-40.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
28.0	-40.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
24.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.0	-40.0	.987	.998	.998	.798	0.000	0.000	0.000	0.000
12.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-12.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-16.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-20.0	-40.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-24.0	-40.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-28.0	-40.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-32.0	-40.0	.500	0.000	.500	0.000	0.000	0.000	0.000	0.000
-36.0	-40.0	.500	0.000	.500	0.000	.500	0.000	.500	0.000
-40.0	-40.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-44.0	-40.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-48.0	-40.0	.568	0.000	.568	0.000	0.000	0.000	0.000	0.000
-52.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-56.0	-40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-60.0	-40.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
-64.0	-40.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
-68.0	-40.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
-72.0	-40.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
-76.0	-40.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-80.0	-40.0	0.000	0.000	0.000	0.000	.137	0.000	.137	0.000
-84.0	-40.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-88.0	-40.0	.568	0.000	.568	0.000	.568	0.000	.568	0.000
-92.0	-40.0	.500	0.000	.500	0.000	.750	0.000	.750	0.000
-96.0	-40.0	0.000	0.000	0.000	0.000	.500	0.000	.500	0.000
-100.0	-40.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-104.0	-40.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-108.0	-40.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-112.0	-40.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-116.0	-40.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-120.0	-40.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
120.0	-44.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
116.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000

112.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
108.0	-44.0	.890	0.000	.890	0.000	.884	0.000	.884	0.000
104.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
100.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
96.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
92.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
88.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
84.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
80.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
76.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72.0	-44.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
68.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
64.0	-44.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
60.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
56.0	-44.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
52.0	-44.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
48.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
44.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
40.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
36.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
32.0	-44.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
28.0	-44.0	0.000	0.000	0.000	0.000	.057	0.000	.057	0.000
24.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-12.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-16.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-20.0	-44.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-24.0	-44.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-28.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-32.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-36.0	-44.0	.568	0.000	.568	0.000	.500	0.000	.500	0.000
-40.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-44.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-48.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-52.0	-44.0	1.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
-56.0	-44.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-60.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-64.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-76.0	-44.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-80.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-84.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-88.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-92.0	-44.0	.500	0.000	.500	0.000	.500	0.000	.500	0.000
-96.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-100.0	-44.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-104.0	-44.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-108.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-112.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-116.0	-44.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
116.0	-48.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
112.0	-48.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
108.0	-48.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
104.0	-48.0	.057	0.000	.057	0.000	.884	0.000	.884	0.000
100.0	-48.0	.890	0.000	.890	0.000	.884	0.000	.884	0.000
96.0	-48.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
92.0	-48.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000

88.0	-48.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
84.0	-48.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
80.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
76.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
68.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
64.0	-48.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
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8.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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-32.0	-48.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-36.0	-48.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-40.0	-48.0	.137	0.000	.137	0.000	0.000	0.000	0.000	0.000
-44.0	-48.0	1.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
-48.0	-48.0	1.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
-52.0	-48.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-56.0	-48.0	.884	0.000	.884	0.000	0.000	0.000	0.000	0.000
-60.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-76.0	-48.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-80.0	-48.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-84.0	-48.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-88.0	-48.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-92.0	-48.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-96.0	-48.0	.137	0.000	.137	0.000	.137	0.000	.137	0.000
-100.0	-48.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-104.0	-48.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-108.0	-48.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
-112.0	-48.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
108.0	-52.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
104.0	-52.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
100.0	-52.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
96.0	-52.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
92.0	-52.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
88.0	-52.0	.057	0.000	.057	0.000	.057	0.000	.057	0.000
84.0	-52.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
76.0	-52.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72.0	-52.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
68.0	-52.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
64.0	-52.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60.0	-52.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
56.0	-52.0	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000
52.0	-52.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
48.0	-52.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000

44.0	-52.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
40.0	-52.0	0.000	0.000	0.000	0.000	.884	0.000	.884	0.000
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-104.0	-52.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
104.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
100.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
96.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
92.0	-56.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.0	-56.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
76.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
64.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
60.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
52.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
48.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
44.0	-56.0	.884	0.000	.884	0.000	.884	0.000	.884	0.000
40.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
28.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
20.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
16.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
12.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
8.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-8.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-12.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-24.0	-56.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-28.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-32.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-36.0	-56.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
-40.0	-56.0	.884	0.000	.884	0.000	1.000	0.000	1.000	0.000
-48.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-60.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-64.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-72.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-80.0	-56.0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
-88.0	-56.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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